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## ELECTRIC HEATING ON A LARGE SCALE.

Electric heating, ideal from so many points of view, has seldom been employed on a large scale, if one except the electric furnace. There are several factors which have combined to prevent this, the two principal ones being the cost of the apparatus itself and the rates charged for electrical energy. It is generally overlooked that while the cost for a single thermal unit in the form of electrical energy may be high, the economy with which this is used brings the total cost much closer to that of an equivalent heating system using fuel. Strictly speaking, of course, it is rather the inefficiency of the fuel-using apparatus which brings the cost of operating them up nearer to that of the electric heater. But there are other factors which at times are even more important than an apparent considerable difference in the actual cost of the heating.

At the recent convention of the American Institute of Electrical Engineers a paper of some interest was read by C. E. Waddell, which describes one of the largest electric-heating systems in this country. This is installed at the Biltmore Estate, Biltmore, N. C., the reasons for its adoption being the cost of anthracite coal and the nuisance involved in its use. These objections led to the introduction of electric heaters for the hot-water system of the house and for performing all the laundry work of the household. The total rating of the installation as it stands is 167 kilowatts, 100 of which is represented by the hot-water heater and sixty-seven by the laundry equipment. The system consumes about 20,000 kilowatt-hours a month, a fairly respectable load.

In the paper Mr. Waddell gave some interesting data respecting the performance of the apparatus installed. The hot-water heater, which is really a small horizontal tubular boiler having electrical heaters inserted in the tubes, was found to give a thermal efficiency of about eighty-five per cent. This seems low, for with complete lagging there should hardly be fifteen per cent loss in radiation. It probably, however, represents fairly well the average all-day efficiency of the heater. The performance of the laundry apparatus is indicated by the records of a number of washes, but seems to vary considerably according to the size of the wash, and a larger number of trials must be noted before one will be able to figure closely on the performance to be expected of such devices. For instance, it was found that on one day sixty-eight pounds of water were expelled for every 100 kilowatt-hours supplied to the electric heater. On another day, for a somewhat smaller wash, 145 pounds of water were expelled for each 100 kilowatt-hours. But while closer figures are desirable from the engineering standpoint, so that the actual

requirements of such apparatus may be known, it should be insisted upon that these are not the controlling factors for determining the selection of such devices. What might be called the "all-over economy" of the system is what should be borne in mind. Time and convenience are as valuable as fuel, and generally less available, and it is very easy to see that in an installation of this kind, although the heating engineers might figure out an enormous difference between the costs of producing a given amount of heat by the two methods, this feature may really be of minor importance and the installation of the electric system be a true economy. Indeed, given cheap electrical energy, it might often be found that there would no longer be any need of providing chimneys in summer residences.

## PROGRESS IN WIRELESS TELEPHONY.

In an interesting paper by Mr. R. A. Fessenden on "Wireless Telephony," at the annual convention of the American Institute of Electrical Engineers, held at Atlantic City, N. J., this week, an excellent review of the history of this art was given. Certainly one of the most fascinating fields thrown open to the modern investigator has been the study of the principles underlying wireless transmission of signals and the development of apparatus for reducing different scientific possibilities to an art. This art was divided by Mr. Fessenden into two periods, the distinguishing features of the two constituting what is really a radical change in the method of transmission. The first period of wireless signaling may be considered as starting from the discovery of electromagnetic induction; that is to say, the transmission of electrical energy from one body to another without any intervening conductor. No real progress was made in the art, however, until after Hertz's work proved the existence of electric waves. A few years after this the discovery that an imperfect contact was sensitive to such waves made possible their utilization for transmitting signals, and fairly satisfactory methods were developed for this purpose. The distinguishing feature of this development was the use of spark discharges for producing the signals, these giving rise to discontinuous, sharply damped waves.

The second period is marked by the introduction of methods for continuous undamped signals which are much better for the purpose for a number of reasons, among which may be mentioned the greater ease of tuning, the increase in the effectiveness of the transmitting and signaling apparatus when using signals of this type, and the improved conditions under which the apparatus is used; that is to say, there is less strain, and, therefore, the apparatus is easier to construct and less liable to break down.

As a result of this development in wireless telegraphy wireless telephony became possible, for, given a continuous undamped signal, to transmit articulate speech it is only necessary to superimpose upon the signal variations corresponding to ordinary telephone currents. This has been done and Mr. Fessenden, among others, has produced a working wireless telephone system. Such a system of communication will for many purposes be far more satisfactory than a telegraph, since the latter requires the services of an expert operator, while the wireless telephone is as simple to use as the ordinary instrument. With such a gain, naturally some sacrifice must be expected, which in this case is that of range of operation. The harmonics rendering the human voice intelligible have amplitudes of varying length, but sometimes only about one per cent as great as that of the fundamental note. Hence, since the transmission of the voice by wireless waves is produced, not by the fundamental wave itself, but by the variations of this, it would seem that the distance of transmission of the voice would be only one-hundredth of that attainable by the wireless telegraph. Fortunately this severe restriction may be considerably modified by increasing, in the transmitter, the ratio of the harmonics to the fundamental and because the ear seems to be more sensitive to spoken words that to mere clicks. The range of transmission of the telephone, however, is considerably less than that of the telegraph, Mr. Fessenden putting it at about one-tenth or more of the latter, but this distance is modified very greatly by atmospheric conditions.

Regarding the possibilities of wireless telephony, it is evident, as pointed out, that there is not much possibility of replacing the present local manual telephone systems, as it is out of the question for every subscriber to install and maintain his own wireless plant. For long-distance transmission, on the other hand, Mr. Fessenden thinks there is a good opening, an advantage of the system being the absence of interruption due to storms blowing down the transmission lines. The flexibility of the system is thought to be greater, as the "wireless circuits" connecting, say, New York and Chicago, and Boston and Chicago, could be used to connect Boston and New York when the regular Boston and New York "wireless circuit" was in use. The most promising opening at present, however, is in connection with its use on shipboard for communication between ships or between ship and land. Here the position occupied by this system is unique. An expert operator is not necessary, as the engineer can take care of the generating apparatus and any one on the ship can use the telephone. There seems to be little doubt that for such purposes there will be rapid development, provided other influences do not interfere.

In connection with studies of the absorption of wireless signals due to atmospheric conditions, Mr. Fessenden has compared his observations with the weather maps of the government and is inclined to think there is some connection between the degree of absorption and the magnetic variation. This suggests that wireless signaling might offer to the Weather Bureau an entirely new means of making weather observations. If there is any connection between the absorption of wireless waves and the conditions of the upper layers of the atmosphere, which are no doubt controlling in important weather changes, careful comparison of the ease of transmission between suitably located stations should give valuable information regarding the atmospheric conditions; and to make this of practical value it would be only necessary to interpret it properly. If, as has been suggested, the absorption of the waves is due to large bodies or

clouds of air in a peculiar condition, this condition, it may be expected, will exert its effect upon the weather. The Weather Bureau has for some time past been experimenting in making long-time predictions, and it has really met with thoroughly creditable success. For this purpose kites and pilot balloons are used. Why not study the relation between weather changes and this electric wave absorption with a view to determining what relations, if any, exist and making use of them when known?

The concluding portion of Mr. Fessenden's paper is devoted to a discussion of the relations between the Government and the private systems. He feels, perhaps naturally, that the restrictions which have been enforced, or are contemplated, have greatly retarded the commercial use of these two systems, and have made it impossible for any such system to be operated profitably to-day. This is an exceedingly important subject deserving the most careful study, not only of those directly interested in the two arts under discussion, but in those other branches of the electrical industry which may ultimately be affected by policies now followed. There are, of course, several sides to this question, and it is one which can not be decided offhand in an arbitrary manner. It would be well if every engineer would make himself familiar with what has already been done in this matter.

## THE RESISTANCE EQUIVALENT OF ELECTROMAGNETIC RADIATION FROM A LINEAR OSCILLATOR.

In another column we publish an article by Mr. Oscar C. Roos on a subject entirely novel, perhaps, to most of our readers, "The Resistance Equivalent of Electromagnetic Radiation from a Linear Oscillator."

The author first cites the reasons for the divergencies found among the results obtained by various workers in attempting to give engineering data upon high-frequency phenomena present in the "verticals" used in the wireless art.

On the basis of a new law derived by him, which shows that any "vertical" of linear type vibrating at its lowest natural period or fundamental has a radiation resistance, R′, of forty ohms, he criticizes Professor J. A. Fleming's subsequent derivation of a similar law, when assuming a linear oscillator and a Hertz oscillator to be electrically equivalent.

The problem was attacked, as indicated, by Dr. John Stone Stone in a paper before the International Electrical Congress at St. Louis in 1904. The linear oscillator is decomposed into an infinite number of Hertz oscillators for all cases, and modifying assumptions pointed out for practical work. The practical formula for the present state of the art is given as a special case of a general formula. This special case, it is interesting to note, has been used in wireless engineering for three years.

The more general formula for R′ consists, when inspected, of an abbreviation for a series of discrete formulæ for definite regions of frequency, stated in units of the fundamental frequency of the vertical. It is evident that at all odd harmonics $R' = 40X$ ohms, where $X = 1, 3, 5, \ldots$ etc. As the author points out, it is at present impracticable to give an *a priori* treatment of the problem.

It is clearly shown that since ideal or practically simple harmonic vibrations have only of late been successfully produced in verticals and have been found to confirm old measurements of R′, we may infer that in at least one American system the damped waves hitherto used have behaved like undamped waves, both in regard to effective resistance and reactances introduced by radiation. This signifies great persistency in the intensity of the successive waves radiated from the vertical and shows that careful engineering methods have really a greater practical scope than the "cut-and-try" efforts which have made the development of radiotelegraphy spasmodically rapid, but to a great extent uncertain.

It is evident that in view of the importance of exact high-frequency measurements of voltage and current at the base of a vertical, to get empirical confirmation of calculations it is imperative to have a criterion of the accuracy of these readings.

Few electrical engineers are required to allow for variations in capacity or inductance with change of frequency. The wireless engineer must, however, be provided with accurately calibrated voltmeters, ammeters, standards of inductance and capacity, eliminating these effects. Frequencies of 60,000 cycles and upward are used and necessitate special methods of checking to avoid ever-present sources of error at these high-frequencies.

It seems desirable that the Duddell arc, when giving nearly pure sinusoidal oscillations, be used for checking the calculations on the vertical reactance and resistance. The high-frequency dynamo is not yet reliable for this work, and all final checks must be calorimetric. The voltage to ground and the current at the base of the antenna being known in two cases, there is obtained R′ and Z, the radiation resistance and the reactance of the vertical at the base, respectively.

Independent resonance measurements give as a check the value of the reactance when the frequency is known. This is a means, as we understand the author, of checking the uniformity of the constants of the antenna per unit length. We infer that the empirical correction of these assumptions and of those made under the MacDonald theory are included in the method as commercially applied, but withheld for the present.

The paper as a whole is timely and shows the present tendency to fusion of theory and practice in the more recent developments of electrical science. The electrical art is indeed becoming more amenable to methods of physical research which a decade ago were looked upon as scientific recreations. With this paper as a starting point the radiotelegraphic engineer is now in a position to make definite engineering tests on a very obscure and difficult problem.

The Society of Wireless Telegraph Engineers, founded in Boston, Mass., February 26, 1907, to which we have referred in our issue of June 13, has had this problem brought to its attention in a number of interesting papers during the past year. It is to be hoped that future papers of this character will receive more publicity through this society.

# Annual Convention of the American Institute of Electrical Engineers.

**The Twenty-Fifth Convention Opened at Atlantic City, N. J., June 29, with Good Attendance and Beautiful Weather—The First Day's Sessions.**

(*Special to the* ELECTRICAL REVIEW, ATLANTIC CITY, N. J., JUNE 30.)

THE twenty-fifth annual convention of the American Institute of Electrical Engineers was called to order by President H. G. Stott at eleven o'clock, Monday morning, June 29, in the Sun parlor of the Hotel Traymore, at Atlantic City, N. J., under particularly promising conditions. The attendance was unusually good for an opening session, the weather could not have been finer, and the fact that all the papers to be presented had been printed and distributed to the membership beforehand is likely to bring out good discussions. As the number of papers to be read is large, it is probable that most of the sessions will be rather long. Indeed, the first session overran the allotted time by three-quarters of an hour; but, on the other hand, the afternoon session was half an hour late in getting under way, and was through half an hour before the time set.

Among those present were A. H. Babcock, San Francisco; H. H. Barnes, Jr., New York; B. A. Behrend, Milwaukee; A. W. Berresford, Milwaukee; James G. Biddle, Philadelphia; Charles Blizard, Philadelphia; Louis E. Bogen, Milwaukee; Morgan Brooks, Urbana, Ill.; George A. Damon, Chicago; F. E. Donohoe, New York; Thomas Duncan, Lafayette, Ind.; W. C. L. Eglin, Philadelphia; J. W. Fraser, Charlotte, N. C.; Albert F. Ganz, Hoboken, N. J.; C. M. Goddard, Boston; A. W. Henshaw, Schenectady, N. Y.; Carl Hering, Philadelphia; Cary T. Hutchinson, New York; Dugald C. Jackson, Boston; Edwin B. Katte, New York; A. E. Kennelly, Cambridge, Mass.; H. B. Kirkland, New York; A. A. Knudson, New York; John Langan, New York; R. D. Mershon, New York; Farley Osgood, Newark, N. J.; Ralph W. Pope, New York; Charles W. Price, New York; Calvin W. Rice, New York; Charles E. Speirs, New York; Calvert Townley, New Haven, Ct.; J. B. Whitehead, Baltimore.

The first session was opened by the introduction of Mayor Franklin P. Stoy, of Atlantic City, who in a humorous address welcomed the Institute to the city, extended the freedom of the town and guaranteed a continuance of the present good weather during the convention.

President Stott, after thanking the mayor for his courteous welcome, delivered the annual presidential address, the title being "The Evolution of Engineering," an abstract of which follows:

Eighty years ago Thomas Tredgold defined engineering as "The art of directing the great sources of power in nature for the use and convenience of man." The question naturally arises: Does this definition hold good to-day? Is it broad enough? If not, how can we better define the engineer's sphere of activity? If we accept Tredgold's definition as our standard, will we reach the position in society which belongs to us by right of education, achievement and highly developed power of logical deduction from facts observed and investigated?

Engineers may be divided into two classes: first, those who believe that the engineer should be restricted to a specific vocation, such as electrical, steam, hydraulic, pneumatic, or sanitary engineering, etc.; second, those who wish to see him take his place not only as an engineer but also as a public-spirited citizen and leader.

The score or more of divisions of electrical engineering which exist to-day are the necessary outcome of the consolidations of manufacturing and other interests into a few large concerns: they are the natural economic results of competition. As these consolidations have undoubtedly resulted in greater efficiency and, therefore, in reduced cost of production, there is every reason to expect a continuance of this evolution from the simple factory manufacturing only one article, to the complex one which manufactures many things. This process of segregation is evidently one of infinite application in all pursuits, tending strongly to an ever-narrower development of the individual, but at the same time increasing his efficiency to a maximum in his own particular specialty. This increase in efficiency, however, will cease if the engineer becomes so highly specialized as to ignore the necessity of keeping in touch with the entire sphere covered by his company, as the evolution of each branch must be synchronized with that of all.

The other class, to which the term "second" has been arbitrarily assigned merely to indicate its numerical inferiority, embraces all those who have broadened their field through self-education, experience, opportunity and natural adaptability for administrative work. The term self-education is used advisedly, as both classes are assumed to start with the same technical training, and as a matter of actual fact the second class almost invariably evolves from the specialists.

The second class is necessarily a restricted one, as, while the legitimate field of work of the engineer is extremely broad and almost unlimited, yet as a rule he has apparently decided to keep in the background and only come to the front when called. The result of this policy is that when the opportunity comes, the engineer is taken at his own valuation and passed over for others who, while not suffering from modesty, are lacking in engineering education and experience, and therefore are forced to call in engineers (to act in a subordinate position) to supply the incumbent's deficiency in the qualifications necessary for the office.

What is the cause of this anomalous situation? Has not the whole body of engineers some share in the blame? We have seen that there is to-day an inherent tendency to specialization in engineering, and that by far the greater number of our members are becoming experts in one or two subjects only, and that comparatively few attempt to keep in touch with the more general aspects of engineering. This condition is caused not so much by a lack of willingness as by lack of time and opportunity.

This centrifugal force acting on our profession has fortunately a nearly equal centripetal one which is found in such societies as the American Institute of Electrical Engineers, in which all can once more be brought back to a common centre on the common ground so clearly described in its constitution, which says that the object of the American Institute of Electrical Engineers "shall be the advancement of the theory and practice of electrical engineering and of the allied arts and sciences."

The conference held in Washington, D. C., last month, which was called by President Roosevelt to consider what steps should be taken to conserve our natural resources, was preceded by a series of conferences held by the presidents of the four national engineering societies, at which a series of broad resolutions were

drafted and afterward presented at the conference as representing the opinions of 20,000 American engineers. The committee on resolutions presented a very able report to the conference, embodying practically everything the engineers had recommended, with one exception, as that particular item had already been covered in a bill introduced into Congress. The resolutions were unanimously adopted.

Several important deductions may be made from this incident. First, united recommendations after careful investigations of facts by engineers, on any public question involving engineering problems, will be not only courteously received but welcomed and highly appreciated by our state and federal governments. Secondly, the facts presented at this conference were of such a far-reaching and important nature that every member of this Institute should feel it is his duty carefully to study the able papers presented, and to further in every way possible the policy of preserving our natural resources. Thirdly, co-operation on the part of the four national engineering societies is absolutely essential to success in any movement of this kind; and, as a corollary, success is certain if we co-operate. Fourthly, if engineers are to take the place in society which belongs to them by right of education and training, they must take an active part in matters of general policy or civic interest, no matter how remote these matters may seem from Tredgold's definition of engineering.

Is it not the engineers' civic duty to take a more active part in public affairs, giving of their special knowledge freely, as may be required of them, at the same time insisting upon the same high ideals of faithful, honest and loyal performance of duties in public life as they have been accustomed to in their every-day work as engineers?

These suggestions are clearly outside the scope of this Institute as set forth in its constitution, so that to carry them out it may become necessary to organize a new society in which membership would be limited to members of the four national engineering societies, and whose object would frankly be to use all legitimate political methods to influence legislation on matters affecting engineering. Such a society could with propriety take up the consideration of many problems of which the public now hears only one side, simply because the engineer has maintained an attitude of reserve. Our large corporations and manufacturers are realizing as never before the benefit of publicity departments, not only for advertising purposes, but for the purpose of disarming adverse criticism by a calm statement of facts.

In conclusion, let us remember that if we wish to progress and assume our proper place in the world, we must be aggressive and not passive in allegiance to our engineering societies; that the day is long past for hiding our light under a bushel, and that instead of Tredgold's definition of engineering, the following more correctly expresses the position of the engineer to-day:

Engineering—The art of organizing and directing men, and of controlling the forces and materials of nature for the benefit of the human race.

Following the presidential address the two papers assigned for the first session were presented, that presented by F. G. Baum being read, in his absence, by Percy H. Thomas. Abstracts of these papers follow:

A paper entitled "Electricity as Viewed by the Insurance Engineer. Should the American Institute of Electrical Engineers Interest Itself in Fire Protection?" was read by C. M. Goddard, secretary of the Underwriters' National Electric Association. In this a brief review is given of the annual fire loss in this country, which for the year 1907 was $180,000,000, while the average for the past thirty-two years has been $134,000,000. Since 1860 the insurance companies have paid out $2,500,000,000 in losses, while the total property loss by fire has been $4,250,000,000 since 1875. There are approximately 300 insurance companies doing business in the country with outstanding risks of $30,000,000,000. The annual per capita loss by fire in Austria, Denmark, France, Germany, Italy and Switzerland varies from twelve cents in Italy to forty-nine cents in Germany, with an average of thirty-three cents. This may be compared with the average per capita loss in the United States of $2.47. Fifty per cent of the fires are due to faults of management, which include all sorts of easily avoidable conditions likely to cause fire hazard. These figures indicate the importance of reducing the fire hazard in this country and justify the continuous efforts which the Underwriters' association is making in this direction. Mr. Goddard explained the requisites of a good fire-protection engineer and insisted upon his honesty of purpose, and pleaded for co-operation of the electrical engineer with the former. He said that electricity may become a serious fire hazard, but due to the regulations which have been enforced the insurance companies believe that any undue hazard from electricity has been and is being guarded against and that electric power gives us to-day the safest illuminant and the safest source of power we have.

F. G. Baum presented a paper entitled "Water Power Development in the National Forests—A Suggested Government Policy." Recently the government has given permits to companies proposing to make power developments on condition that the permits be revokable at the pleasure of the Secretary of the Interior and that there be a conserving water royalty charge by the government on the power output of the plant. Temporary permits are objected to by power companies, and objection has also been raised to the conservation charge when it is based on the output of the plant. The author, after discussing the importance to the country of proper development of the water powers, suggests that a proper conservation charge can be made only on the basis of the cost to the government of that which is furnished by the government. He thinks that the proceeds from any particular privilege shall not be devoted to any other watershed or section nor to any purpose except the particular privilege asked for. The conservation charge would have a maximum limit at any given time, which could be determined by calculating the yearly cost of the conservation to the government. This charge can be fixed for a period of, say, ten years, when a new adjustment may be made and a new charge made yearly to meet the changing cost of maintenance. The question of the proper conservation charge is entirely a separate matter from the charge to be made for lands and rights of way for development, and the two matters should be kept distinct. Rights of way and lands necessary for the development should be charged for on a fair basis of value as would be determined if the lands belonged to private parties and a value had to be set on them for power purposes by a court or a commission. Such lands should be deeded outright by the government to the power company, and the only changing condition then, as time goes on, would be the yearly conservation charge.

President Stott then introduced President-elect L. A. Ferguson, who asked for a continuation of the support which had been given his predecessors and outlined certain phases of work which he thought

the Institute might take up with profit. It should endeavor to instruct the younger members in engineering matters. It should bring into closer touch with its active work those engineers who have taken up executive duties and who are now generally only associates and not members. It should endeavor to interest the leading members of other engineering societies. At the present time there is much duplication of work in many local ities because of the different electrical societies there. These should be brought together under the Institute leadership. In conclusion Mr. Ferguson emphasized the degree to which the success of the Institute, as a whole, depends upon its members individually.

The discussion on the papers which had been read was then opened by J. H. Finney, who took up Mr. Baum's paper somewhat in detail and disagreed with all the latter's important conclusions. Mr. Finney believes that the resources of the country belong to the country as a whole and the benefits derived from each of them must not be confined to its section. He quoted, with approval, from President Roosevelt's opening address before the recent conservation conference, in which the same stand was taken, and in which it was asserted that we should consider ourselves as the trustees of resources upon which future generations will depend, and we should so manage as to harmonize the work of private capital, of the state and of federal governments. Taking up in detail Mr. Baum's proposals for government conservation charges, Mr. Finney contended that they were not in accordance with practice in other lines of business and that practical conditions make a fixed rate desirable. The policy of the government may be summed up in the phrase "Equal justice to all."

E. R. Taylor also dissented from Mr. Baum's views, holding that the whole country should profit from the resources of any favored section.

Professor J. P. Jackson, referring to President Stott's address, said that while the engineer alone might be backward in asserting himself, as a body, engineers carry weight. Turning then to Mr. Goddard's paper, he said this was most timely. He suggested it might be advisable to have a committee of engineers to consider means of reducing the tremendous economic waste which now takes place from fires.

P. V. Wells, of the Forest Service, outlined the general policy of that service with respect to the protection of water powers. He took issue with Mr. Baum, saying the latter confused the policy of the service with the desires of Congress. The Forest Service does not like the present system of revocable permits and would like to make them irrevocable, if not violated, for a period of, say, fifty years. This Congress will not allow. The service now specifies the charges which will be made, so far as it can, and it requires that the permits be used, setting times for the beginning and completion of the work. Uniform charges are best, for many reasons. Mr. Baum's analogies do not hold, for land is free to settlers and irrigation is furnished them at cost, while companies seeking a profit from irrigation are required to pay for it. The service recognizes the value of storage and does not charge for the water stored, but it does charge for the head developed by such storage. The charges of the service are too low to obstruct any development, but give the developers of the most favorable sites the best chances of making a profit.

A. H. Babcock said the various speakers seemed to misapprehend Mr. Baum, who merely took the stand that when the people of a district develop its resources they should enjoy the benefits thereby secured. Taking up Mr. Goddard's paper, he said that he had watched the fires started by the San Francisco earthquake, and it was a remarkable fact that these had all started in the section of the city fed by the large storage battery of the United Gas and Electric Company through its underground wires. In the outlying districts the power was cut off by the breaking of the pole lines and there were no fires.

Dr. C. P. Steinmetz said he agreed with Mr. Baum that the present method of making conservation charges is not just, but he did not, therefore, admit the justice of the latter's proposed method. The argument which he makes is the very one now being used with much effect against the setting aside of forest reservations. The people in distant sections are told that they will not be benefited. But the reverse is the truth. A water development in Maine saves fuel there and helps to keep the price of coal down; and the price of iron in San Francisco is dependent upon the cost of coal. If local interests only are conserved there can be no excuse for governmental aid. There are two features to be considered: the development of our resources as completely as possible and the encouragement of private capital in the work.

Regarding Mr. Goddard's paper, Dr. Steinmetz said the question is really broader than a mere fire risk. There is the risk to life and the risk to capital. It would be proper for the Institute to take the matter up in its broadest aspects. There might be a committee for considering the safeguarding of all interests, or it might be better to secure and publish papers on such topics, as it is exceedingly difficult to lay down rules applicable to all situations. What is not good practice in cities may be good practice in small towns.

L. A. Ferguson said Mr. Babcock's statement regarding the San Francisco fires was remarkable, to say the least. The Commonwealth Edison Company, of Chicago, had tried overhead high-tension wires in the outlying districts and had abandoned them as bad practice. He thoroughly agreed with Dr. Steinmetz.

Mr. Babcock replied that he had not attributed the fires to the underground wires, but had merely called attention to a remarkable coincidence.

William McClellan said that the destruction of our forests has ruined many good water powers, and those which have escaped should help to rehabilitate the ones damaged.

C. F. Scott commented upon President Stott's address, saying the Institute should endeavor to co-operate with other engineering societies and thus secure a greater influence.

The first session was then adjourned.

MONDAY AFTERNOON'S SESSION.

The second session was called to order at 2.30 Monday afternoon, and the four papers on the programme were read and discussed.

In a paper entitled "A Study of Multi-Office Automatic Switchboard Telephone Systems," W. Lee Campbell discussed the enormous economic waste which the wire, cable and conduit equipment of the telephone system involves, the reasons which make this waste expedient in manually operated systems, and how it can be reduced in systems employing automatic switchboards. Of the three items of cost —that of apparatus, that of office and buildings, and that of wire, cable and conduit—the last is the largest. Under usual circumstances this part of the system costs more than the other two parts combined, and not infrequently it represents two-thirds of the entire first cost. The author states that in the average telephone system, containing but one central office, nine-tenths of the cable and wire plant is idle during the peak of the load and ninety-eight per cent is not in use under average conditions. Party-line

service is but a partial remedy for this condition, and the only method known of materially reducing the great economic waste thus represented is to divide the central office up into a number of smaller offices. The saving which may be effected in this way depends upon local conditions. It is evident that with a number of central offices well distributed the subscribers' lines will be considerably shorter, so that it will only be necessary to have a sufficient number of trunks between offices to handle the maximum business. On the other hand, a single large central office usually costs less to operate. The author then constructs an arbitrary curve showing the probable number of calls per day per line on systems of different sizes, and on this basis he constructs other curves representing various items in first cost and operating expense for systems varying from 1,000 to 14,000 lines. In this way he compares the manual system with the automatic. It was found that the cost per line of manual equipment increases rapidly with the size of the office. With the automatic system this increase is relatively slow. If the equipment is for 5,000 lines or more, the space occupied by the automatic system is only about half that of the manual, and with a station of 14,000 lines, the total cost of the office equipment of the automatic system is about equal to that of the manual. Curves are given showing the various items in the cost of operation of the two systems for central offices of different sizes. From these curves it is found that when the ultimate number of subscribers which may be expected in one office district in fifteen years does not exceed the capacity of a single multiple board—that is, 10,000 lines—and there is no concentrated group of subscribers at a considerable distance from the best location of the single office, a one-office system will be the most economical when manual equipment is used. However, there are conditions under which it is profitable to divide such systems, as the saving and annual charges on the wire and conduit will more than offset the increase in the central office expenses. Roughly speaking, an economical arrangement of the average manual system will include offices not much less than two miles apart. There is an objection, however, to the multi-office manual system on account of the slower service given and greater liability of mistakes, but there are no such objections to the divisions of the automatic systems; and, on the other hand, this division can be carried much further than in the manual system with a much greater saving in wire and conduit. Several assumed cases are then considered and the most satisfactory arrangement for each is found. For example, a particular 50,000-line system is divided into five main offices, one of which is subdivided into eight branch offices, and the other four into five branches each. This gives a system with an ultimate capacity of 100,000 lines, which can be handled with instruments having five numbers. The author then dwells upon the advantages of the multi-office system, such as the facility with which this is expanded or can follow the shifting of the population. Such a system is easily adapted to meet any unexpected demand.

The discussion was opened by the reading by P. H. Thomas of two communications dealing with the subject of the paper. The first, from A. B. Smith, said the writer had long hoped that the automatic telephone would solve the city telephone problem. It now seemed to have reached that stage, as the multi-office system described offered many advantages. However, it seemed to involve a disadvantage in requiring a system of heavy trunks. Would not an automatic trunking switch solve the whole problem?

The second letter was from John Wicks, and it agreed, in general, with Mr. Campbell's views. Now that the automatic system offered party line service—that is to say, inexpensive service—it had removed one of the serious obstacles to its wide use. What is wanted is an inexpensive trunking system, and this, too, is now available in the two-way trunks, which are good for service both in calling and answering.

Professor Morgan Brooks said that it is wrong to plan for a system which will keep the wires in use the greater part of the time. What is wanted is a system which will always have the wires free when a call is to be made. To this end the automatic assists, as it saves time in disconnecting.

L. E. Hurtz emphasized the great saving due to the switching units which make small exchanges possible.

R. A. Fessenden, in a paper entitled "Wireless Telephony," gave a brief historical review of the development of wireless signaling. The first period began with the work of Henry in 1838 and ended with 1902. The second period, beginning with 1902 and continuing up to the present time, has been marked by the gradual abandonment of the damped-wave coherer system and the substitution of the elements of the sustained-wave non-michrophonic contact type. A good deal of the new apparatus devised in this work is described. Regarding the possibilities of this system, Mr. Fessenden thinks there is no immediate prospect of its taking the place of local exchanges, but there is a good field for it for long-distance lines. For transmarine work and communicating between ships it is exceptionally well suited. Regarding the range of transmission, there is little difficulty governing distances of 100 miles. Beyond this atmospheric absorption begins to make itself felt. The author also explains his views of the retarding effect which the various governments of the world have exerted on the development of this important new art. There was no discussion on this paper.

A paper by Dr. A. E. Kennelly and S. E. Whiting on "The Measurement of Rotary Speeds of Dynamo Machines of the Stroboscopic Fork" was read. This calls attention to the use of the stroboscopic fork by Dr. C. V. Drysdale and describes the authors' work in developing this instrument to meet their own particular needs. An electrically operated fork is used, upon the sides of which are two movable weights shifted by means of cords and wheels and with a pointer indicating the change in the pitch of the fork with the position of the weights. The slit screens are carried on the ends of the fork and through the slits a peculiar target is viewed. This contains, first, a square, then a pentagon, a hexagon, a ring of fourteen marks, and a similar outer ring of eighteen marks. By viewing this screen through the slits the speed can be easily read within one part in 1,800. Attention is called to the fact that there is no patent on the stroboscopic method of measuring speeds, and it is free to any one who wishes to use it.

The discussion on this paper was opened by J. B. Taylor, who said that the engineer is often not so much concerned with actual speeds as with differences in speed, and he described the stroboscopic method used at Schenectady for this purpose.

Professor H. A. Perkins said that he used three forks of different pitch, and by counting the number of coincidences which occurred when any one was in use the range could be extended 150 revolutions each way. This, taken with the subdivisions of the frequency into one-half, one-quarter, etc., gave practically the entire range from nothing to the highest frequency.

Dr. C. H. Sharp said the instrument

exhibited by Dr. Kennelly was not only very accurate, but portable, and hence would be most useful in practice.

C. E. Waddell, in a paper entitled "Notes on the Electric Heating Plant of the Biltmore Estate," described the electric heating systems which have taken the place of various other devices in the Biltmore house. The reasons for the change were, first, the objection to burning soft coal and the high price of anthracite coal, and the desire to do away with the hauling of fuel and ashes, with the incident noise and dirt. Electrical energy was available at eight and one-half mills per kilowatt-hour, so that this made possible a comparison of the economic features of the coal and electric systems. Due to the somewhat irregular character of the loads, the electric system is not under such a great disadvantage as would at first be assumed. The hot water for the house is heated in a boiler three feet in diameter, five feet long, containing twenty flues, each of which encloses a five-kilowatt heating element. The laundry has been completely fitted up with ironing, dry and washing apparatus, with a total rating of sixty-seven kilowatts. The author concludes that electric heating has suffered from the fact that its economic possibilities have usually been considered from its thermal-unit value, and that the lesson to be drawn from the Biltmore installation is that a careful analysis of all the conditions may disclose the fact that while theoretically a disparity exists, nevertheless, economy may accrue due to the better operating conditions. He also takes occasion to state that certain of the auxiliary appliances accepted as standards in lighting work will have to be abandoned or remodeled for heating purposes. Fireproof or asbestos-covered wire is to be preferred to rubber, even in conduit installations.

The discussion was opened by P. H. Thomas, who said that a large heating equipment, such as described, became a real engineering problem and should be treated as such.

A number of questions were asked, such as the cost of electric heating as compared with fuel, details of the electric steam boiler and other uses of electricity. Mr. Waddell replied to these, but nothing new was brought out.

The second session was then adjourned.

In the evening a reception was held at the Casino, a large attendance being present.

W. H. B., Jr.

## The First Year's Work of the New York State Public Service Commission.

On July 1 the Public Service Commission for the First District of New York state, created under the Public Service Commissions Law, was one year old. It has done noteworthy work in two fields during the year—those of lighting and transportation, substantiating Governor Hughes' belief in recommending its creation to succeed the old Rapid Transit Commission and the State Commission of Gas and Electricity.

William R. Willcox, chairman of the commission for the First District, has stated that, in spite of great difficulties, he is satisfied with the results of the work done by the commission. A few of the most notable results accomplished through the work of the commission are better express and local service in the New York subway, and more frequent service on all the elevated roads and greatly increased service on all the more important surface lines. The car movement over the Brooklyn Bridge has been materially accelerated.

Evils of financial mismanagement and consequent deterioration in operating service have been disclosed, and the experience gained by the investigations has resulted in action looking toward the prevention in the future of the abuses of the past.

The commission proposes to reform the system of accounting, and will make such changes as will compel companies to make monthly allowances for depreciation and to set aside funds for the replacement of worn-out rolling stock.

After much study the commission has decided that where a field is monopolistic —that is, where a monopoly, properly regulated, can best serve the needs of the community—it is inadvisable to encourage the entrance of competitors. It is believed that the soundness of this principle will be indicated in the future by the improvement in service of the public service corporations.

The commission has perfected plans for the Fourth avenue subway in Brooklyn, and has taken definite steps toward the building of new subways and elevated lines.

In the field of gas and electricity the commission has done effective work in the testing of gas and electric meters. The electric light companies, at the solicitation of the commission, have resumed the giving of breakdown service to periodical consumers.

## The New Holland-American Liner Rotterdam.

On Wednesday evening, June 24, a large company of representative business men and prominent citizens were the guests of the Holland-American Steamship Company at a dinner on the new steamship Rotterdam, which has just been placed in service. This is the third largest transatlantic liner, and its appointments are exceptionally complete. It is electrically lighted throughout, provided with a remarkable system of ventilation and heating, and electric elevators, telephones, heating and cooking devices render a trip very luxurious.

This vessel is the fourth of the same name to have been built and employed in transatlantic service by the Holland-America line. The first Rotterdam appeared in 1872 and was a steamer of 2,000 tons. The second was a four-masted steamer of 4,500 tons, and appeared in 1885. The third was brought out in 1897, was of 8,300 tons, and was the first twin-screw steamer of the line. The new Rotterdam of 1908, with a tonnage of 24,170 and a displacement of 37,190 tons, eclipses all her earlier namesakes not only separately but also collectively, the single tonnage exceeding the total of the three predecessors.

In point of luxurious appointment and accommodations the Holland-American company considers this craft "the last word" in ocean liners.

## Disagreement in Insurance Companies' Suit Against Denver Lighting Company.

During 1907, in Denver, Col., a low-potential wire was crossed by a high-tension conductor and a series of fires, alleged to be on the circuit of the low-potential wire, were started. A number of dwellings and a church were burned, and it was held that in each case the flames had started around the electric light fixtures. The insurance companies settled the claims, took the subrogation, and brought suit against the lighting company for the recovery of $30,000, the amount of insurance paid upon the church loss.

The principal point involved was whether the electric light company had protected its wires by properly grounding them to carry off any accidental high-tension currents. The insurance companies had experts from Chicago and Cleveland to testify that if the low-tension wires had been properly grounded no fire could have resulted, but the company had experts to testify that the ground was of little value except for protection to life, and the jury disagreed, the voting being four to eight against the insurance companies. Barger & Hicks, of Chicago, and Sylvester Williams, of Denver, represented the insurance companies. Another trial will be held.

## AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

FORTY-FIRST CONVENTION, HELD AT ATLANTIC CITY, N. J., JUNE 22 TO 25.

The first session of the forty-first annual convention of the American Railway Master Mechanics' Association was called to order at 9.30 A. M., Monday, June 22, by the president, William McIntosh, superintendent of motive power of the Central Railroad of New Jersey, at Atlantic City, N. J. Prayer was offered by the Rev. J. H. Setchell. The association was welcomed to Atlantic City by Mayor Stoy, and response was made on behalf of the association by J. F. Deems.

In his presidential address Mr. McIntosh emphasized the importance of careful selection in the membership of the association, and indicated the necessity ultimately of the Master Mechanics' and Master Car Builders' Associations being consolidated into one powerful, united, representative organization. The progress of the times, the conditions of the work and the character of the problems demand this step.

The report of the secretary, Joseph W. Taylor, showed that there were 862 active members, nineteen associate members and thirty-seven honorary members, a total of 918. The receipts of the secretary's office for the year had been $5,200.33, and the expenses $5,200.33, with unpaid dues amounting to $1,440. The report of the treasurer showed a balance on hand of $1,912.72. The secretary announced that the executive committee recommended that the annual dues for the present year should be fixed at $5, the same as last year, which recommendation was approved.

The report of the committee on "Mechanical Stokers" was presented by J. F. Walsh. This was the subject of considerable discussion, and on motion the present committee was continued and made a standing committee.

The report of the committee on "Blanks for Reporting Work on Engines Undergoing Repairs" was presented by Theodore H. Curtis, chairman.

The report of the committee on "The Proper Width of Track on Curves to Secure the Best Results with Engines of Different Lengths of Rigid Wheel Base" was presented by F. M. Whyte. This report was received and the subject continued as recommended by the committee.

The paper entitled "Fuel Economy" was submitted by W. E. Squire, and a topical discussion held on the subject "The Smoke Nuisance."

This was followed by a topical discussion on "Alloy Steel."

The report on "Washing Out Locomotive Boilers" was then presented by H. T. Bentley.

The second session was called to order at 9.30 A. M. on June 23.

J. F. DeVoy presented the report of the committee on "Castle Nuts."

The report on "Apprenticeship System" was presented by C. W. Cross. On motion it was resolved that the report of the committee be adopted and that principles recommended by the committee be endorsed by the association as recommended practice, and substituted for the "Code of Apprenticeship Rules" adopted in 1898.

The report of the committee on "Superheating" was presented by H. H. Vaughan. This report was accepted and the committee continued.

The report of the committee on "Mallet Articulated Compound Steam Locomotives" was presented by J. E. Muhlfeld.

The paper by A. W. Gibbs, entitled "Tests of Briquetted Coal," was presented.

The third session was called to order at 9.40 A. M., June 24. The first report presented was that of the committee on "Size and Capacity of Safety Valves," by F. M. Gilbert, chairman.

The report on "Revision of Standards" was read by W. H. V. Rosing.

The topic, "Standardization of Locomotive Parts" was discussed, the discussion being opened by G. R. Henderson.

This was followed by the report on "Various Designs of Four-Cylinder Compound Locomotives in Service."

After the report of the committee on nominations was adopted the election of officers for the ensuing year was held. The following officers were elected: President, H. H. Vaughan, assistant to vice-president Canadian Pacific Railroad; first-vice president, G. W. Wildin, mechanical superintendent New York, New Haven & Hartford Railroad; second vice-president, C. E. Fuller, assistant superintendent motive power and machinery Union Pacific Railway; third vice-president, J. E. Muhlfeld, superintendent motive power and machinery Baltimore & Ohio Railroad; treasurer, Angus Sinclair, New York city; executive members, H. T. Bentley, Chicago & Northwestern; T. Rumney, Erie; T. H. Curtis, Louisville & Nashville.

## Westinghouse Reorganization Plan.

The United States Court at Pittsburg, Pa., on petition by receivers of the Westinghouse Electric and Manufacturing Company, has entered an order directing the payment of interest due July 1 upon the funded debt and floating debt of the company, and also interest due August 1 on collateral notes of the company. This amounts to $500,000 interest due on bonds and notes, due on July 1, and $180,000 interest on a $6,000,000 loan, due on August 1. The receivers stated that they had sufficient funds to meet these obligations.

At the meeting of the readjustment committee on June 26 it was stated that the details of the circular to be issued to stockholders and bondholders were practically worked out and that the circular would be issued during this week. It was also stated that the merchandise creditors' plan, after a necessary delay to complete details and secure the small remaining amount of subscribers to new stock, would be put into effect about September 1. The two months' extension will enable the committees to perfect the reorganization plan proposed, and it is believed that before September 1 announcement will be made regarding the changes in the personnel of the company.

Great satisfaction is expressed over the completion of the important contract recently announced with the Bergmann Electric Company, of Germany, whereby that company will construct a large plant for the manufacture of Westinghouse single-phase apparatus. The company will install the Westinghouse electric traction system in Germany, and the combination has been formed for the purpose of furnishing the requirements of the Prussian state railway administration, which has decided to electrify the steam railways, $12,500,000 having been appropriated to begin the work.

## American Electrochemical Society.

The fall meeting of the American Electrochemical Society will be held in New York city, probably in October. The dates contemplated are October 30, with a session at the College of the City of New York, and October 31, with a session at the Chemists' Club, 108 West Fifty-fifth street.

## International Congress on Electrical Units and Standards.

The following memorandum as to the proposals to be laid before the Congress on Electrical Units and Standards to be held in London in October next has been prepared. The congress will assemble on October 12.

The general object of the International Congress on Electrical Units and Standards, which is to meet on the invitation of His Majesty's government in London in October, 1908, is to consider and advise as to the steps which should be taken to bring about agreement in the definition of electrical units which form the basis of legislation in different countries, and in the methods of constructing and employing the electrical standards necessary to give effect to these definitions.

It is hoped that the delegates to the congress may find themselves able to embody their conclusions in draft articles which might be commended to the several governments represented as a basis for uniform legislation and administration in relation to electrical units and standards.

The fundamental units of electrical measurement are the ohm, the ampere and the volt. Of these two are primary units, being independent, and the other secondary or derived. It is generally agreed that the ohm should be accepted as one of the primary units. There is some difference of opinion as to whether the ampere or volt should be the second. This point will be one for the conference to consider.

Again, the ohm is realized by means of the resistance of a column of mercury of definite dimensions, the ampere by means of the electrolytic deposition of silver, and the volt by aid of a standard cell.

If this method of realizing the units be accepted by the congress, specifications for the ohm and ampere will call for consideration, while the standard cell must be selected and the method of setting it up prescribed.

In view of the scientific questions raised in connection with each of these matters, including also the choice of the two primary units, it will be suggested at an early meeting of the congress, should such a course appear to be desirable, that the congress should appoint a small technical commission of experts to discuss the question, and report thereon to the congress.

The congress will also be asked to consider the best methods of securing uniformity of administration in the future, and for arriving at a decision on any questions left undecided at the close of the congress.

It is desirable to have some definite questions before the congress, and with this object the following propositions embodying conclusions arrived at by the representatives of the various National Standardizing Laboratories which met at the Reichsanstalt in 1906, and which are also generally in accordance with the decisions of the Chicago congress held in 1893, will be brought forward as a basis for discussion:

1. That the ohm shall be the first primary unit.
2. That the ampere shall be the second primary unit.
3. That in consequence the volt shall be treated as a secondary or derived unit.
4. That the international ohm be defined as the resistance at the temperature of melting ice of a column of mercury of uniform cross-section terminated by planes at right angles to its length 106.3 centimetres in length and 14.4521 grammes in mass.
5. That the international ampere be defined as the unvarying electrical current which, when passed through a solution of nitrate of silver in water, deposits silver at the rate of 0.001118 gramme per second.
6. That the international volt be defined as that electromotive force which, when applied steadily between the ends of a conductor of resistance one international ohm, produces a current of one international ampere.
7. That the Weston cadmium cell be adopted as a convenient standard of electromotive force, having, at a temparture of seventeen degrees centigrade, an electromotive force of .... international volts, but that it is undesirable that the number representing the electromotive force of this cell should be the subject of legislation in any country.
8. That specifications dealing with the methods of setting up mercury standards of resistance, of realizing the ampere by the deposition of silver and of preparing standard cells, be issued with the authority of the congress, and that for this purpose a technical commission be appointed to prepare these specifications.
9. That the congress consider and advise as to the best method of securing uniformity with regard to the fundamental electrical standards for the future.

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Exports of copper for the first five months of 1907 were 66,044 tons; for the first five months of 1908, 133,872 tons. Imports of copper for the first five months of 1907 were 56,250 tons; for the first five months of 1908, 36,600 tons.—*Copper Gossip.*

## FINANCIAL REPORTS OF ELECTRICAL COMPANIES.

TOLEDO RAILWAYS AND LIGHT COMPANY.

The report of the Toledo (Ohio) Railways and Light Company for the month of May and five months ended May 31 shows May gross of $198,973; expenses, $109,444; May net, $89,529; other income, $81; total income, $89,610; charges and taxes, $71,719; May surplus, $17,891. Five months' gross, $1,028,607; expenses, $574,930; five months' net, $453,677; other income, $2,774; total income, $456,451; charges and taxes, $348,373; five months' surplus, $108,078.

DETROIT UNITED RAILWAY COMPANY.

The report of the Detroit United Railway Company, Detroit, Mich., for the month of May and five months ended May 31 shows May gross of $599,643; expenses, $365,875; May net, $233,768; other income, $4,464; total income, $238,232; charges, $135,661; May surplus, $120,571. Five months' gross, $2,649,635; expenses, $1,726,116; five months' net, $923,519; other income, $23,944; total income, $949,463; charges, $675,794; five months' surplus, $271,669.

ELECTRIC STORAGE BATTERY COMPANY.

The preferred and common dividends on the stock of the Electric Storage Battery Company have been cut from one per cent quarterly to three-quarters of one per cent. This is the second cut in six months. Three months ago the rate was reduced from one and one-quarter per cent to one per cent.

While business has fallen off very greatly since last October, an improvement has been manifested within the last few weeks. A number of inquiries have been received from large customers, and several orders have been taken. While the company's shipments are not as great as those of a year ago, the amount of orders on its books for future delivery is as large as last year's.

MONTREAL STREET RAILWAY COMPANY.

The report of the Montreal Street Railway Company, of Montreal, Quebec, for the month of May and eight months (October 1 to May 31) shows May gross of $313,678; expenses, $169,723; May net, $143,955; charges, etc., $61,801; May surplus, $82,154, compared with a May surplus of $75,823 in 1907. Eight months' gross, $2,341,551; expenses, $1,485,623; eight months' net, $855,928; charges, $385,788; eight months' surplus, $470,140.

## NEW WEST EXCHANGE AT CINCINNATI, OHIO.

BY J. E. PEAVEY.

The telephone system of Cincinnati, Ohio, scores another improvement in the new West Exchange, located at 930 York street. Early in 1907 the Cincinnati & Suburban Bell Telephone Company decided to further improve its telephone system in that city and provide for the rapidly increasing business by building an entirely new exchange to take the place of the old West office, located at Eighth and Freeman avenues. Consequently a new exchange centre for the district was obtained, and without delay an exchange building erected with sufficient capacity to accommodate the largest type of multiple relay switchboard with auxiliary apparatus and ample district offices.

The new building has three stories and a deep, well-lighted and ventilated base-

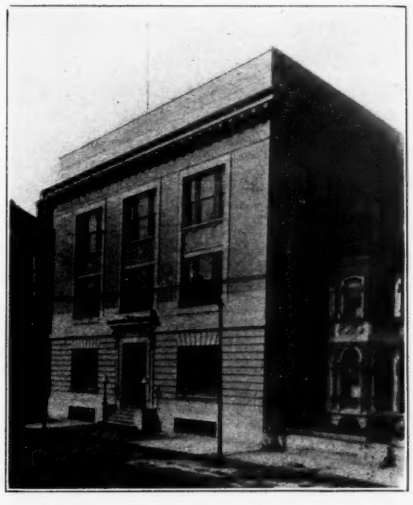


FIG. 1.—NEW WEST EXCHANGE OF THE CINCINNATI & SUBURBAN BELL TELEPHONE COMPANY, CINCINNATI, OHIO.

ment. As shown in Fig. 1, the building is very substantially constructed of blue granite and Shawnee speckled brick, and is fireproof throughout. The interior framing is of steel and all partitions are of tile and the floors concrete, with staircases constructed of steel and white Italian marble. Corridors and vestibules are also of white Italian marble, with floors of a neat mosaic design. The only wood entering into the construction is used for floors on the concrete to soften the tread, doors and a few minor details. The windows in external walls exposed to adjoining property have metal casings and wired glass, thereby insuring against fire from external sources. The entire third floor of the building is used for the switchboards and as an operating room. The second floor contains the apparatus room and operators' quarters. The ground floor is used entirely for district offices and the basement contains the heating system and exchange power plant, cable runway and various accessories belonging to a first-class building of this character. All wires enter the building through a tunnel from the exchange manhole in the street. After the cables enter the basement they are supported on a unique runway or rack to a point directly beneath the main frame, where they rise into the main frame terminals. Fig. 2 shows this cable rack or runway in the basement.

Standard Western Electric equipment is used throughout. The switchboard has an ultimate capacity of 9,600 subscribers' lines and a present equipment of 5,000.

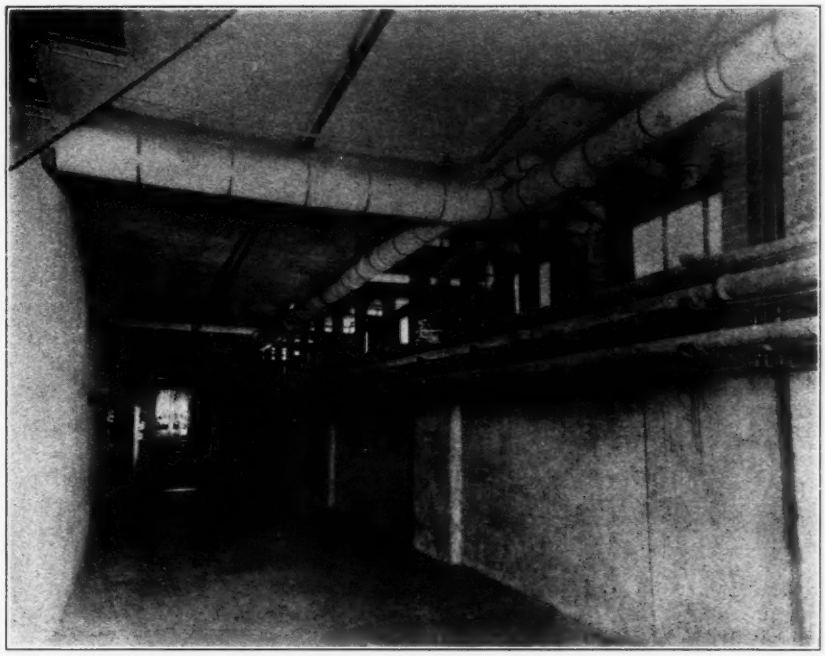


FIG. 2.—CABLE RUNS IN SUBWAY—WEST EXCHANGE OF THE CINCINNATI & SUBURBAN BELL TELEPHONE COMPANY.

Fig. 3 is a view of one corner of the operating room, showing a portion of the front of switchboard. Fig. 4 is a rear

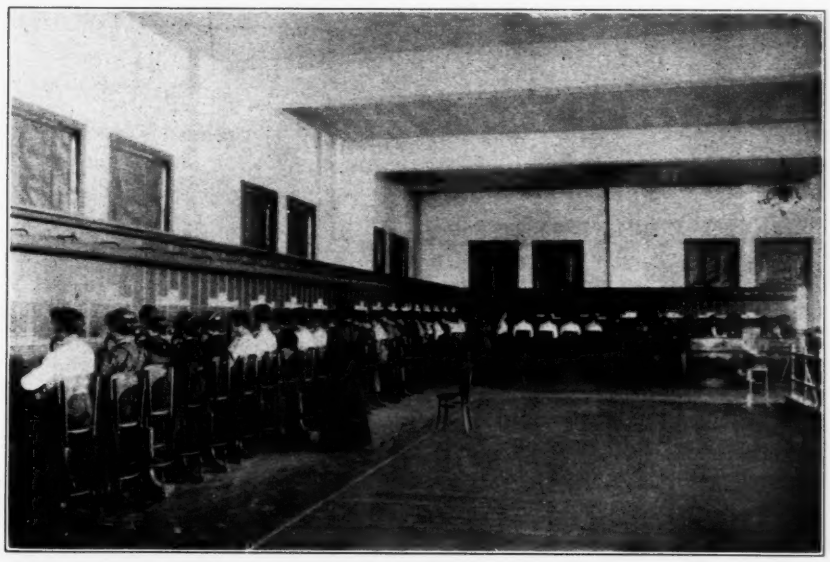


FIG. 3.—WEST EXCHANGE OF THE CINCINNATI & SUBURBAN BELL TELEPHONE COMPANY—FRONT OF SWITCHBOARD.

view of the power switchboard, and gives some idea of the generally substantial character of the construction and assembly throughout this exchange installation.

The exchange possesses several distinct features of importance, the principal of

which is the use of forty-eight volts on all cords for transmission purposes—both local and toll. This is the second office so equipped by this company, forty-eight volts having been adopted as a standard for all offices having a comparatively long substation loop. Machine or automatic ringing from the trunk or "B" operator position is also used, which materially reduces the "don't answer" reports and otherwise aids in economical operation. The interior arrangement of the exchange, both from an artistic and operating standpoint, is very complete, every facility for operating and maintaining the plant having been carefully worked out and provided for.

This being the eighth large exchange built by the Cincinnati & Suburban Bell

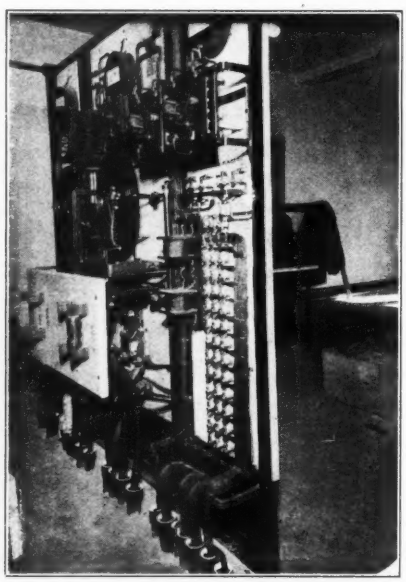


FIG. 4.—REAR OF POWER BOARD AT WEST EXCHANGE.

Company in the past five years, as a consequence a large fund of practical information on modern exchange design and construction was at the company's disposal. The transfer or cutting-over from the old to the new exchange was accomplished at 2 P. M. on Saturday, February 15, 1908, and required just 100 seconds. So successful was the cut-over that not one of the eleven other exchanges in the city was aware when the transfer was made. Considering the hour of the day, with its operating load, this is considered quite a feat.

All credit for this handsome exchange and its successful completion must be given to B. L. Kilgour, general manager of the company, who gave considerable personal attention to the engineering work; also to T. C. Reed, superintendent of the cable department, for the thorough workmanship that permitted the exchange to be transferred from the old to the new building without a single case of trouble or complaint.

## THE TUNGSTEN LAMP.[1]

BY E. F. TWEEDY.

In considering the commercial effects of the introduction of the tungsten lamp the present, together with the possible users of electric light, may be divided into three classes according to their probable relations to this new illuminant. The first class consists of existing customers who are now using electric light at what might be termed the "point of saturation," based on the present standard of illumination, thereby reducing their watt capacity and consequently decreasing the revenue of the central station. To illustrate this a concrete example of this class will be cited. The United Cigar Stores Company has consistently recognized the advertising value of brilliantly lighted stores. To carry out this idea effectively they have been large consumers of electricity, their total outlay for electric lighting on Manhattan Island alone during the year 1907 being about $80,000. By means of the tungsten lamp they now expect to reduce this expense by nearly one-half, without sacrificing in the slightest degree their present high standard of illumination.

The second class is likewise composed of present consumers, but in their case the illumination is below the "point of saturation" above referred to, for the present standard of illumination. This class has limited its quantity of illumination, the reason for this being largely one of dollars and cents. The question now arises as to whether this class will utilize the tungsten lamp for the purpose of securing the same illumination for less money, or to secure a greater amount of illumination for the same money. The latter alternative seems more probable, but central stations can not wait passively for such a result. It is time for active work among such a class of customers, in order to point out to them the advantages which they will derive from a greater amount of illumination, now that a cheaper source of light is at hand. Unless this is done central-station income from this class will probably be diminished, at least temporarily. For the present, while the tungsten lamp is made only in sizes of comparatively high candle-power, it does not seem likely that it will replace the carbon lamp in domestic lighting. It is very probable that multiple lamps of smaller candle-power will soon be upon the market; in fact, a 110-volt tungsten lamp of twenty candle-power, consuming twenty-five watts, was exhibited at the recent Chicago convention, and appeared to be a complete success. A lamp of this and smaller size will find an extensive field in the lighting of the home. In using this lamp for domestic lighting, however, considerable care must be used in the manner in which it is installed. The carbon lamp with clear glass bulb and without a diffusing shade is frequently placed directly in the line of vision. With the tungsten lamp, the intrinsic brilliancy of which is over twice that of the carbon lamp, the practice above described must be discontinued, or else the money saved in light bills will soon reach the pocket of the oculist. The tungsten lamp must be installed well above the line of vision, or else be so shaded that its intrinsic brilliancy will be largely reduced, and this fact should be thoroughly impressed upon all customers who are about to install this lamp. It is evident that such a course is desirable from the central station standpoint. By installing tungsten lamps in the manner described, the lessened efficiency of the installation, aside from the lamps, will offset in some measure the high efficiency of the light sources themselves.

The third class consists of those who are at the present time employing some other means for securing illumination than by electricity, in the interest of economy solely. (It is assumed that this is the only reason a person could have for using any other illuminant in preference to the electric light.) It is from this class that the lost revenue from classes one and two must be regained, and there is every reason to believe that not only will any possible loss be thus recovered, but that the electric lighting industry will experience a tremendous growth as a result of its being able to secure a class of customers which has heretofore been unobtainable.

In order to secure these possible customers described under class three above, this company has decided upon a campaign directed, at the start, against the gas arc. A proposition will be made to the users of this type of illuminant whereby the company will arrange for the wiring and for the installing of a tungsten fixture to replace the gas lamp. The customer will be allowed to select his own fixture from a number of designs covering a considerable range in price, and the installation will be made under the customer's direction. The total cost of the wiring, the fixture and the tungsten lamps will be assumed by the company, but this

[1] Abstract of a paper read before a meeting of the Contract and Inspection Department of the New York Edison Company, New York city, June 11.

amount will be repaid by the customer, without interest, in twelve consecutive monthly payments, which will be added to the monthly bills for current. After the final payment has been made the entire equipment, excepting the lamps, which are to be returned at the end of their life, will become the property of the customer. If the customer should vacate the premises before the last instalment is paid, or if the contract should be terminated before the final payment, it is understood that the installation may be transferred to the successor under a similar arrangement, to continue until all payments have been made. If such a transfer should be impossible, the original customer must pay the full amount necessary for a complete liquidation.

There are a vast number of gas arcs in use in this city at the present time, but the policy outlined above should result in their nearly complete elimination. A few figures comparing the cost of operation of a gas arc to that of a tungsten fixture, giving approximately equal illumination, may be of interest. The majority of gas arcs, particularly those installed in small stores, are in service on a rental basis. The Municipal Lighting Company has a large number of arcs so installed. Their charges are seventy cents a month for the four-mantle lamp and a dollar a month for the one having six mantles. These prices include maintenance, so, adding the cost of the gas consumed by the lamp, the total operating cost is secured. Some figures recently obtained under actual working conditions were as follows: Cost of gas consumed by a four-mantle lamp burning four hours a day (excluding Sundays) for one month, was $1.62; adding to this the rental charge of seventy cents makes a total monthly cost of $2.32. For equal illumination a tungsten fixture would be required having four forty-watt or possibly three sixty-watt lamps. Assuming the latter combination, with a life of 1,000 hours for the tungsten lamps and current at ten cents per kilowatt-hour, a total monthly cost of $2.35 would result. To this might be added an interest charge upon the cost of the equipment, which would reach its full value only at the end of the first year, when all payments had been made, and is really too insignificant to be included, as the total cost of the equipment, excluding lamps, will rarely exceed $15. Compare the above figures and then take into consideration the many advantages possessed by the tungsten lamp not shared by the gas arc, namely, the color of the light, which is nearly a pure white, as compared with the greenish-yellow color of the gas lamp; a comparative absence of heat, the presence of which makes the gas arc decidedly objectionable during the greater part of the year; and lastly, the fact that the atmosphere is not vitiated. It is stated that a four-mantle gas arc consumes as much oxygen as a dozen people, and the truth of this statement is evident to one who has entered a certain class of small stores on a winter's day. Even if the cost of a given amount of illumination is slightly greater with the tungsten lamp than with a gas arc—which is probably true in the case of certain inverted mantle arcs—the advantages enumerated above should outweigh any such slight difference in cost.

The use of the tungsten lamp for show-window lighting will be touched upon. The fundamental requirements for effective window lighting are: (1) That the sources of light be concealed from the eyes of the passerby, or, if this is impracticable, that they be surrounded by diffusing globes or shades, so that their intrinsic brilliancy will be largely reduced; (2) that a sufficient quantity of light be thrown upon the goods to be displayed so that the portion of this light which is reflected to the eyes of the observer will produce the desired effect, namely, a vivid visual perception of the goods which are on display.

## A Single-Phase Locomotive for the Prussian State Railways.

A brief description is given in *Electrical Engineering* (London), for June 11, of the new single-phase locomotive which has been built for experiment on the single-phase line of the Prussian State Railways, at Oranienburg. The locomotive consists of two two-axle units coupled together. Three of the four motors are driven by single-phase motors of the Winter-Eichberg compensated repulsion type, and a fourth motor may be mounted on the remaining axle if found necessary. Each motor is rated at 350 horse-power on the one-hour-and-seventy-five-degrees-centigrade basis. With this load the speed of the motor is 450 revolutions a minute. Using forced draft, the continuous capacity of the motors is 250 horse-power, the speed then being 500 revolutions a minute. These motors are said to differ but little from the 350-horse-power motor experimented with two years ago. The latter weighed five and one-half tons, had six poles, and was designed for twenty-five cycles. The motors are geared to the locomotive axles with a ratio of 1 to 4.21, and the driving wheels have a diameter of 4.6 feet, so that the speed at the one-hour rating is seventeen and one-half miles an hour with a total draw-bar pull of 22,000 pounds. At the continuous output rating the speed is nineteen and one-half miles an hour with a draw-bar pull of 14,300 pounds. The maximum speed of the locomotive is thirty-five miles an hour. The total weight of the two units is fifty-nine and one-half tons. The locomotive is supplied with current at 6,000 volts, twenty-five cycles, by means of two bow collectors, one on each unit. The pressure on the wire is nine pounds, which is controlled by compressed air. The main transformer reduces the pressure from 6,000 to 1,000 volts. It is air-cooled by forced draft supplied from a fan driven by a thirty-horse-power Winter-Eichberg motor, which is started by means of a series choking-coil which is automatically short-circuited when a speed of 700 revolutions a minute is attained. The air for the transformers and motors is drawn through choke filters to free it from dust. Compressed air for the brakes, bow collectors and other devices is supplied from a compressor driven by a seven-horse-power motor which is automatically started when the pressure falls below six atmospheres. The main controller has four starting positions and four running positions, and a simplified controller for operating at the lowest voltage only is supplied for use in switching operations. By means of a choking-coil, the centre of which is connected to the motor lead and the ends to transformer tappings, the connections are changed from point to point without short-circuiting the transformer. The contactors controlling the connections are operated by current from the main transformer at a pressure of 300 volts.

## American Street and Interurban Railway Association.

The annual convention of the American Street and Interurban Railway Association and the affiliated associations of the Accountants, Engineers, Claim Agents, Transportation and Traffic Managers, and Manufacturers, will be held at Atlantic City, N. J., on Monday, Tuesday, Wednesday, Thursday and Friday, October 12 to 16. The days upon which the different associations will hold their meetings have not been definitely decided upon, but these will be announced in the near future.

The exhibit of the Manufacturers' Association will be located on Young's "Million-Dollar" Pier, and it is expected that a display even more attractive than that of last year will be given.

## THE RESISTANCE EQUIVALENT OF ELECTROMAGNETIC RADIATION FROM A LINEAR OSCILLATOR.

BY OSCAR C. ROOS.

In presenting this article the writer first wishes to call attention to one or two preliminary considerations which have given rise to some obscurity in the treatment of such problems as the wireless telegraph engineer is called upon to solve. It is then purposed to indicate the method of an engineering attack upon the problem of the number of watts expended in the ether as electromagnetic radiation with a given harmonic current at the base of the vertical used in wireless telegraphy. There follows the resulting solution of the equally important question of the current intensity at the base of the vertical with a given harmonic electromotive force.

On examination of several papers which have appeared to account for the radiation from a vertical, it becomes increasingly evident that a tendency exists to ignore the inherent differences in the physical behavior of Hertz oscillators and the large oscillators of the vertical, inverted "L," "T"-shaped and other types used as verticals in wireless telegraphy. Three serious consequences have immediately ensued to mar the accuracy of all analyses based on the assumed similarity: (1) Deductions made as to the resistance equivalent of radiation from hot-wire measurements have not led to consistent results when the frequency was changed, (2) reactances measured at the "driving point" of a vertical wire have not furnished consistent values of current, and (3) the expected resistance equivalents and the observed have not, in analyses hitherto presented, agreed within engineering limits of accuracy.

The subject of the linear oscillator as a whole is an extremely intricate one if a rigorous method of analysis (such as is given in MacDonald's "Electric Waves") is used. Abraham and Hack have given a treatment of the linear oscillator which, while elegant from a mathematical standpoint, is not as accurate in practice as MacDonald's, and whose artificial assumptions allow no simple conception of the dissipative agencies in action. These, however, are easily grasped from a study of the engineering theory of radiation developed by an American physicist and engineer, J. S. Stone, and presented before the International Electrical Congress at St. Louis in 1903 and subsequently republished in these columns (October 15, 1904). Although this theory has been before the technical and scientific world for more than three years, no practical application seems to have been made of it, as far as the writer is aware, in any phase of the wireless telegraph industry, except as undertaken by one or two personally interested mathematicians and members of his technical staff. Hence, as was to be expected, the errors mentioned above as the result of applying cumbersome analyses directly to the problem have crept into the work even of writers of some considerable authority on electrical matters.

Professor J. A. Fleming, author of "The Principles of Electric Wave Telegraphy," in a paper on the Poulsen arc and continuous electric oscillations, published in these columns on November 9, 1907, identifies himself with those who have fallen into the error of basing their work on the assumption that Hertz's treatment of the electric doublet shows it equivalent to a linear oscillator, and has, in addition, "grafted" on these assumptions a physical condition taken from MacDonald's analysis above referred to, which analysis is based on an entirely different treatment from that of Hertz. I shall not go into details as regards this forcible "hybridization" of formulæ; as in a future paper I expect to present MacDonald's results made practical for wireless telegraph engineers with the aid of Stone's engineering method.

In indicating a more accurate treatment of the problem of the resistance equivalent of radiation (a term first used by Stone) I must state that after all is said and done the acceptance of this theory is really based on facts rather than analysis, since no published analysis that is likely to be put to use for several years yet, is complete enough to take all the factors of the problem into consideration, especially that of the variability of the resistance equivalent of radiation with leakage, etc.

In Professor Fleming's article above mentioned there occurs a formula giving the power in watts of a Hertz oscillator vibrating at its fundamental

$$W = 40\,\pi^2 \frac{l^2}{\lambda^2} A^2$$

As an expression of the power of a Hertz oscillator or electric doublet the above is correct, since we may take the current to be practically uniform along the axis. When applied by Professor Fleming to a linear oscillator or wireless telegraph vertical, however, whose height is not negligible in comparison with the wave-length of the emitted radiation, it is seriously in error, since the current is not uniform along the axis, but is distributed according to a "cosine law" with a maximum at the base and nodes at the free ends of the vertical wire and its earth "image," if we assume uniform constants per unit length of the vertical.

In the summer of 1905 I was led, in the pursuit of a mathematical research on the inductance per unit length of a vertical, to a formula for the energy of radiation, whose accuracy has since been shown by the increased accuracy of predictions as to resistance of radiation; some have been verified, experimentally, by observers in a different field of electric wave engineering.

This practical engineering formula is a special case of a more general result, which includes all frequencies of vibration from zero to infinity, and to which I shall refer later on, but which in the present state of the art would not be called upon for accurate quantitative results.

Returning to Professor Fleming's article, we find the formula given by him would be correct for a wireless telegraph antenna if his $l$, or length of complete oscillator, were replaced by a smaller length $l_H$ equal in value to the length of the equivalent Hertz oscillator acting at a distance. This quantity $l_H$ is found by using Stone's method of decomposing the linear oscillator vibrating at its fundamental frequency into an infinite number of Hertz oscillators of length varying according to an inverse cosine law, between zero and the length of the vertical. This law follows from the general differential equations of the problem as solved for current, which in all cases varies as a circular function along the complete linear oscillator, and in the case of the fundamental frequency of vibration gives the cosine curve with antinode of current at the equatorial plane.

The linear oscillator may, accordingly, be looked upon, as regards its resultant field at a distance, the criterion of radiation by Poynting's theorem, as being composed of an infinite number of elementary Hertz oscillators, each of whose lengths is expressible by the formula $l_H = \frac{v}{n} \cos^{-1} \frac{nx}{v}$ and the average or effective length $l_{eH} =$

$$\frac{v}{n} \int_{-a}^{+a} \cos^{-1} \frac{nx}{v} \frac{dnx}{v}$$

where $x < +a > -a$

and $$\frac{na}{v} = \frac{\pi}{2}$$

In the above $a$ is the length of vertical or air wire; $v = 3 \times 10^{10}$ centimetres

per second, the velocity of light; $n$ ($= 2\pi f$ where $f$ = frequency) is the "vectangular velocity" and is variously called "periodicity," "oscillation number," etc., which are misnomers; as it has the dimensions of an angular velocity and in fact is the angular velocity of the vector whose projection on a plane would show the harmonic time relations of the current in question.

The above quantity $l_{eH}$ is the effective or average length of a Hertz oscillator giving the same field and energy flow at a distant point, as our linear oscillator. A physically more direct procedure is to decompose the linear oscillator into an infinite number of elementary current filaments of different charges, but equal lengths, in accordance with Hertz's own expressions. The results of the two methods are in this instance, however, identical.

In the multiple antennæ used by the Stone Telegraph and Telephone Company it has been found that the assumption that $l = \frac{\lambda}{2}$ at fundamental frequency, where $l = 2a$, or twice the height of the vertical and $\lambda$ = wave length emitted, is very approximately true. The uniformity of the vertical wire constants along its length is quite sufficiently accurate for engineering practice. Now, the effective length $l_{eH}$ may be taken as $l_{eH} = \frac{2}{\pi} l$ when we have the fundamental vibration, and Professor Fleming's formula then becomes

$$W = 40\,\pi^2 \left(\frac{2}{\pi} l\right)^2 \frac{A^2}{\lambda^2} = 160\,\frac{l^2}{\lambda^2} A^2$$

for the complete linear oscillator where A is the maximum current, or $W = 40\,A^2$ watts.

The hot-wire ammeter, however, reads effective values, hence $W = 80\,A_e^2$ where $A_e$ = effective amperes for the complete oscillator and $R^1$, the "resistance equivalent of radiation," equals forty ohms for the air wire alone. This result has been the basis of regular engineering treatment of transmitting and receiving problems of all kinds since it was discovered and has been incorporated in patents now pending for radiotelegraphy, suitable constants being applied where the conditions are not those assumed in this case.

If we "hybridize" MacDonald's result with the above conditions by assuming for a vertical $l = \frac{\lambda}{2.5}$ and an approximately cosine law of current distribution along the vertical, we find that $R^1$ comes out as about twenty-five ohms instead of sixty-four, as given by Fleming.

Passing now to the more general method of viewing the problem, we will first take the region of frequencies below the fundamental, since most verticals in use are loaded with inductances. Such verticals can vibrate effectively, solely at frequencies below the fundamental on account of the increase of $R^1$ as the square of the frequency, although there are theoretically an infinite number of frequencies at definite periods apart in the frequency scale where such natural vibrations are possible. As we approach zero frequency the current distribution curve flattens until in the limit with zero frequency it approaches a straight line. This range of frequencies, while not as interesting from an analytical standpoint as that above the fundamental, is, however, the practical one for wireless telegraph

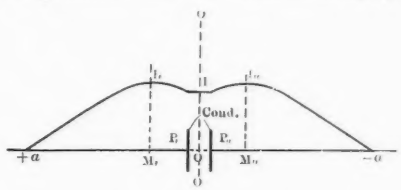



FIG. 1.—CURRENT DISTRIBUTION IN A LINEAR OSCILLATOR.

engineers in the present published state of the art. The formula covering it is

$$R^1 = 40\,csc^2\,k\,\frac{\pi}{2}\left(1 - \cos k\,\frac{\pi}{2}\right)^2 \text{ ohms}$$

where $k$ is the fraction of the fundamental frequency at which the vertical is to vibrate, assuming unit current at base of vertical, and maximum current therefore as $csc\,\frac{na}{v} = csc\,k\,\frac{\pi}{2}$. This, of course, is a special case of the more general formula for $R^1$ covering all frequencies previously referred to.

For frequencies just above the fundamental we find by reference to Fig. 1 that the current distribution in a linear oscillator is equivalent to two complete systems of Hertz oscillators, which overlap by almost a quarter wave-length, and whose radiative tendencies may be considered absent where each passes through the equatorial plane; in other words, the current loop or antinode is shifted toward the free end of the wire and equals the current at the base multiplied by $csc\,\frac{na}{v}$ where $a$ is the length of air wire in cm. $n$ = vectangular velocity

$v = 3 \times 10^{10}$ cm. per sec. = velocity of light.

To illustrate: In Fig. 1 we have a complete linear oscillator represented with the current distribution along its length due to a "forced" oscillation above the fundamental of the vertical, and having an inductive reactance requiring, therefore, a condenser $c$ at the equatorial plane to neutralize said inductance reactance at the "driving points" $P_I$ and $P_{II}$.

Since the current throughout the condenser C is constant and equals $I_o$, the maximum current $I_I$, or $I_{II}$, is $I_o\,csc\,\frac{na}{v}$. This distribution of current holds within engineering limits in a helix of wire having uniformly distributed electrical constants, as in the case of the linear oscillator assumed. It is interesting to note a substantial empirical confirmation of the above theoretical distribution by C. J. Watson in the London *Electrician* of January 3, 1908. He found that with capacity added to a helix as an exciting connection for stationary waves that the node of pressure, and therefore current antinode, was shifted toward the open end of the vertical.

We may assume the effect of radiation at the driving point of the antenna or linear oscillator to be that of a purely non-inductive resistance. Assuming the distribution of current and potential to the left of the equatorial plane OO to be due to the image of the right-hand distribution. The distance of the antinodes of current from the equatorial plane $= \frac{ak}{1+k}$ where $k$ is the fractional part of the fundamental frequency $\left(\text{say } \frac{1}{3}\right)$ by which the impressed frequency exceeds it, therefore $OM_I = OM_{II} = \frac{a}{4}$ and $I_I = I_{II} = I_o\,csc\,60°$. Fig. 1 incidentally shows the danger of drawing conclusions from hot-wire readings at the "base" of a linear oscillator vibrating above its natural or free period. If we re-draw Fig. 1 to show solely the variable part of the current distribution curve, as in Fig. 2, we have the basis of an engineering method of attack on the problem of all higher frequencies.

If we conceive a series of Hertz oscillators which have infinitesimal uniform currents and which vary in length from $+a$ to $-a$ (or $2a$) to $l_1$ $o_1$ $l_1$ at $o_1$ and zero at $I_o$, according to the inverse current distribution law, we shall obtain a mathematical "current sheet" if these elementary oscillators are laid side by side, as it were. It is readily seen that the dotted parts of the distribution curves

on opposite sides of the equatorial plane contribute nothing to the radiation; in fact, the only questionable point of this analysis to be checked by practice is raised by the tacit assumption made that all the elementary Hertzian oscillators from $2a$ to zero have the same radiative power, when it is quite evident by an application of MacDonald's analysis that more radiation takes place from the outer halves of the oscillator than the inner: as a corrective tendency, however, the relatively stronger equatorial fields seem to restore the uniformity of action between the above parts. We may now represent Fig. 2 by a series of Hertz oscillators as in Fig. 3. Four elementary oscillators are shown, $a_1\ a_2$ and $a_3\ a_4$ are treated as one oscillator of length $a_1\ a_2 + a_3\ a_4 = 2a_1\ a_2$, $b_1\ b_2 + b_2\ b_3 = 2\ b_1\ b_2$ and $c_1\ c_2 + c_2\ c_3 = 2\ c_1\ c_2$, etc.; hence the averaging is simply a problem of quadrature applied to the current sheet "area," $+ a\ \mathrm{I}_1\ \mathrm{I}_0\ \mathrm{I}_{II} - a + a$.

The fractional overlapping of the central "current distribution sheets" becomes less and less as we pass to frequencies above the fundamental and is zero at the octave—an impossible case, however, since the reactance at the driving point is infinite for the octave and for all even harmonics including zero frequency, according to Stone's formula (which has been amply verified by engineering results).

$$Z = -\mathrm{L}_1\, v\, ctn\, \frac{na}{v}$$

where Z = reactance $\mathrm{L}_1$ = inductance per cm. (c. g. s.) $2\ a$ = length of complete linear oscillator.

Proceeding to frequencies above the octave, we have a supplementary overlapping of the middle "current sheet" units, and on each side of this region two complete "current sheets" in opposite phases from the joined middle sheets, and each of length $= \frac{\lambda}{2}$.

To illustrate: In Fig. 4 we have a current distribution curve giving us a sheet of elementary Hertz oscillators for a frequency (say) two and one-third times that at the fundamental —our frequency unit in this analysis— *i. e.*, above the octave. Since for the octave $\frac{na}{v} = 2\left(\frac{\pi}{2}\right)$, for this frequency $\frac{na}{v} = \frac{7}{3}\cdot\left(\frac{\pi}{2}\right)$ radians. However, as the maximum current at the octave with unity current at equatorial plane is $csc\ \pi = \infty$, we have a discontinuity to take account of in our formula. It will be noticed that since our equivalent length Hertzian oscillator is derived by calculating the average "height" of the Hertzian oscillators in the oscillator current-sheet, by taking the "area" of same, we can ignore

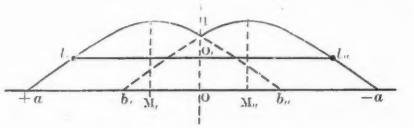


FIG. 2.—VARIABLE PART OF THE CURRENT DISTRIBUTION CURVE OF A LINEAR OSCILLATOR.

the symmetrical image of either side in obtaining this result and hence only one set of oscillators is indicated in Fig. 4.

In Fig. 5 we have the current distribution curve giving the Hertzian oscillator "sheet" or "area" for a frequency about 3.5 times fundamental frequency. In

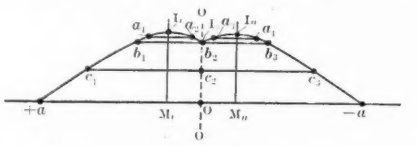


FIG. 3.—LINEAR OSCILLATOR REPRESENTED AS A SERIES OF HERTZ OSCILLATORS.

both Figs. 4 and 5 we notice a partial or "basal sheet" and a complete "sheet," the latter corresponding to a complete linear oscillator of length equal to length of "sheet base" $\mathrm{C}_2\ \mathrm{C}_3$. This linear oscillator is, of course, equivalent to a radiation resistance of eighty ohms, since its current distribution is sinusoidal and it may therefore be considered to be a separate added linear oscillator vibrating at its fundamental. By taking the "area" of the basal segment $oc_1\mathrm{I}_0$ and getting its

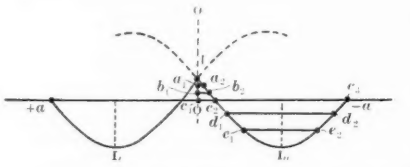


FIG. 4.—CURRENT DISTRIBUTION CURVE FOR A SHEET OF HERTZ OSCILLATORS.

ratio to the half area of the above complete added "oscillator-sheet," we obtain a ratio which gives us the "effective length" $l_{eH}$ of the Hertzian oscillator corresponding to the above basal segment: this ratio, squared and multiplied by forty ohms, gives us the resistance equivalent of the basal sheet to be added to the complete or eighty-ohm "sheet." Thus the problem for all higher frequencies resolves itself into the determination of the above "basal area" effect in any case and the addition to it of a number of equal linear oscillators vibrating at their common fundamental.

We have accordingly:

Below the fundamental

$$\frac{na}{v} = k\,\frac{\pi}{2} \text{ and } \mathrm{R}^1 = 40\ csc^2\,\frac{na}{v}\left(1 - \cos k\,\frac{\pi}{2}\right)^2 \qquad (1)$$

Between fundamental and octave

$$\frac{na}{v} = (1+k)\,\frac{\pi}{2} \text{ and } \mathrm{R}^1 = 40\ csc^2\,\frac{na}{v}\left(1 + \sin k\,\frac{\pi}{2}\right)^2 \qquad (2)$$

Between octave and first harmonic

$$\frac{na}{v} = (1+k)\,\frac{\pi}{2} \text{ and } \mathrm{R}^1 = 40\ csc^2\,\frac{na}{v}\left[\left(1 - \cos k\,\frac{\pi}{2}\right)^2 + 80\right] \qquad (3)$$

Between first harmonic and double octave

$$\frac{na}{v} = (3+k)\,\frac{\pi}{2} \text{ and } \mathrm{R}^1 = 40\ csc^2\,\frac{na}{v}\left[\left(1 + \sin k\,\frac{\pi}{2}\right)^2 + 80\right] \qquad (4)$$

The general formula becomes by induction,

$$\mathrm{R}^1 = \frac{40}{\sin^2\frac{na}{v}}\cdot\left[\left(1 - \left\{\sin m\,\frac{\pi}{2} + \cos m\,\frac{\pi}{2}\right\}\cos\frac{na}{v}\right)^2 + m - \sin^2 m\,\frac{\pi}{2}\right] \qquad (5)$$

where $\frac{na}{v} = \left(m+k\right)\frac{\pi}{2}$, $m$ being an integer and $k$ a fraction.

The locus of $\mathrm{R}^1$ as a function of the fundamental vibration as a frequency unit is roughly shown in Fig. 6.

For all even harmonics we are confronted with the very significant limitation of a theoretically infinite value for $\mathrm{R}^1$ considered as a resistance operating at the driving point or base of the vertical. The physical reason for this becomes clear if we recollect, (1) that every linear uniform current element contained in the "oscillator sheet," being as regards radiation a separate elementary Hertz doublet of given length, offers an elementary dissipative (or radiative) resistance, according to the strength of its field at a distance, and (2) that the filaments which may be considered to end on the "base" or earthed part of the fictitious "current sheet," are, when the limiting cases of the even fundamental frequencies are approached, but a small and even vanishing percentage of the total sum or "area" of the current filaments composing said "sheet"; hence the rise of $\mathrm{R}^1$ with the increase in the ratio of maximum current to basal current of antenna. It is well to remember that since the reactance and

$R^1$ of the linear oscillator are assumed, of course, in series, that the high reactances, approaching infinity at the even multiple harmonics, are, in addition to the reactance of the vertical *per se*, a separate means of limiting the current at the base.

In the above treatment it has been tacitly assumed that the series of synchronously vibrating segments on a vertical, under the conditions for stationary waves permits practically uniform maximum amplitudes of current in each segment, and that the radiation from any segment, according to Hack's amplification of Abraham's work on the linear oscillator, does not seriously modify the radiation from any other, and thirdly, that the field at a distance, due to a uniform current filament, is proportional to length of said linear elementary current. When mutual influences between current "segments" are appreciable they can be replaced by equivalent reactances and resistances, after attack by a modification of Heaviside's operational methods of analysis for this class of problems, and Stone's engineering treatment may then be applied to get the new form of $R^1$. However, the complexity of the results is not always compensated for by the gain in accuracy.

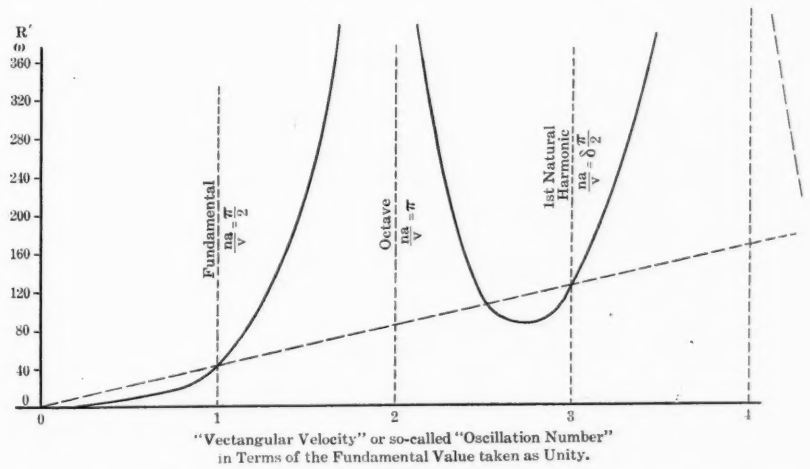



FIG. 6.—ROUGHLY DRAWN GRAPH OF FUNCTION R, "THE RESISTANCE EQUIVALENT OF RADIATION" AT DIFFERENT FREQUENCIES.

The final problem of the actual basal effective current I in a linear oscillator with an electromotive force E may be attacked in the usual manner of alternating-current problems as follows:

We know that the reactance "drop" to be accounted for in the vertical at the driving point is IX where $X = -L_1 v \operatorname{ctn} \frac{na}{v}$ and the resistance "drop" $= IR^1$. Therefore the vector sum or total drop gives us

$$I^2R^2 + I^2X = E^2$$

which gives us a cubic for I in the known quantities $R^1$, X and E.

In conclusion it may be stated that, as a matter of fact, the preceding general formula for $R^1$ has been amply verified both at and below the fundamental frequency by using substitution experimental methods of tuning to the vertical and

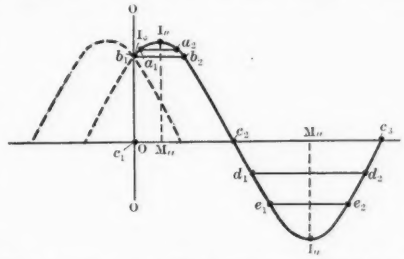



FIG. 5.—CURRENT DISTRIBUTION CURVE FOR A SHEET OF HERTZ OSCILLATORS FOR A DIFFERENT FREQUENCY.

thus reproducing the "contained $R^1$," *e. g.*, it is common practice to find at a frequency approximately one-half that of the fundamental a substitution value for $R^1$ of nine to ten ohms as required by this analysis, and not sixteen ohms, according to Fleming's formula. We have in the field of wireless telephone experiments further external evidence to corroborate the above analysis, these experiments indicating a value for $R^1$ of nine ohms at approximately the half fundamental frequency. These are cases taken at random from many to illustrate the importance of engineering instead of rule-of-thumb in wireless telegraphy—a field which already bids fair, by the use of precision methods aided by analysis, to outrank in accuracy of performance prediction some of the older branches of electrical engineering.

## BOOK REVIEWS.

**"Die Elecktrizitätswerkbetriebe in Lichte der Statistik." Fritz Hoppe. Leipzig. Johann Ambrosius Barth. Cloth. 325 pages. 116 curve sheets and 197 tables. 7½ inches by 11 inches. Price, paper bound, 12 marks; cloth, 13 marks 20 pfgs.**

This is the second edition of a similar treatise on statistics of power-plant operation, to which much material has been added, thus bringing it up to date. The book is divided into nine chapters and one appendix. The first chapter covers the development of electric power plants in Germany, discussing the number of plants, capacity of same, the system of power distribution employed, etc. Chapter ii, besides other material, gives the power consumption per section of the country, per inhabitant and the cost of same. Chapters iii, iv and v describe the kind of plant, *viz.*, steam, hydraulic or gas, and the type of machinery installed in each case. In these chapters the actual cost of operation is treated in detail. Chapter vi discusses the financial end of power-plant design and construction. Chapter vii discusses the rates to consumers, *viz.*, flat, maximum and minimum demand, sliding scale, etc. Chapter viii gives prices paid by railroads and factories, and the generating cost and the selling price. The last chapter treats of other Continental power plants as well as Great Britain and South Africa. The appendix gives different systems of bookkeeping used in power-plant operation.

It is evident that the compiling of the data mentioned, which are a fractional part of the whole, is tedious work. To facilitate matters, an exhaustive index is appended. The book is of great value to consulting and operating engineers and capitalists, particularly those of European countries.

**"How to Become a Motorman." Second Edition. V. B. Livermore and J. R. Williams. New York. D. Van Nostrand Company. Cloth. 248 pages. Illustrated. 5 by 6½ inches. Furnished by the ELECTRICAL REVIEW for $1.**

This is intended to be a thoroughly practical book for the motorman. The fundamental principles of the electric motor are briefly explained and then the different sizes and appliances are taken up separately, each being described with much detail, the methods of operation explained at length, and wire diagrams being given. All the systems of car and train control in use in this country are explained. The last portion of the book is devoted to study of air-brake systems for electric cars, the controlling apparatus being explained fully. The final chapter contains general rules for the guidance of motormen and conductors.

## THE SMALL STATION AND ITS ECONOMICAL OPERATION.[1]

BY J. I. WHITTLESEY AND PAUL SPENCER.

The manager of the small plant generally has to be his own designing as well as his own operating engineer. He seldom, if ever, can afford to call in a consulting engineer to guide him in his work. There is undoubtedly a tendency in electrical engineering as in all other matters to follow the prevailing fad, and many small plants throughout the country have, in order to keep in the fashion, adopted complicated and costly improvements entirely unsuited to their conditions.

It should be a cardinal principle in all station design that no piece of apparatus or any appliance should be installed that can not justify itself, not only on the basis of the economy promised by the manufacturer of the appliance, but also on the most conservative basis; full consideration being given to its first cost, its depreciation, the additional labor that its use may entail, and the question of extensive repairs, which can be made in a small plant only with difficulty.

Every additional piece of apparatus in the station is an additional source of possible trouble and cost. It will be found that many of the so-called labor-saving devices and other promised adjuncts to economy are applicable only to stations of comparatively large size and have no place in such stations as this paper is considering.

The simple design is always the safer one to adopt for the manager of a small station. If he will be content with following out the lines suggested in this paper for the design of his plant, he will save himself a great deal of time and useless worry in attempting to decide the question of economy to be obtained from the refinements recommended, and he will certainly not run the risk of making the serious and costly mistakes into which some managers have been drawn.

While it is important that the design of the station should be simple, simplicity of design does not mean lack of design, and it is probably of even more importance in the cost of the small plant than of the large plant that it should be arranged at the start so that it can be developed along definite lines.

Every station manager should forecast for himself the development of his load so that he may have some idea of the conditions it will be necessary for him to meet from year to year in the future. It is an excellent plan to assume some reasonable percentage of growth in order to ascertain what point at the end of a period, say ten years, the expected load on the station may reach, and to draw up some tentative plan, at least, to meet such an estimated load, working backward on the problem to see when the additional apparatus will have to be installed, in order that the capacity may keep pace with the growing load.

With such a more or less definite plan in mind the extensions can be made from year to year in the most economical manner, so far as first cost is required, and with a uniformity in the design and size of apparatus that will help toward efficient operation. Such a definite plan will also enable the station manager to avoid the costly rearrangement of buildings and of apparatus, which have so frequently been necessary in the past and have swelled so much the station's scrap pile.

Assuming that a new station is to be built, certain broad features of the design can be laid down as essential.

First of all, the plant will undoubtedly supply alternating-current service, generating and distributing at 2,300 volts, multiphase, sixty cycles. One class of apparatus only should be installed, and the entire business, whether commercial lighting, street lighting or power, should be supplied at sixty cycles, alternating current.

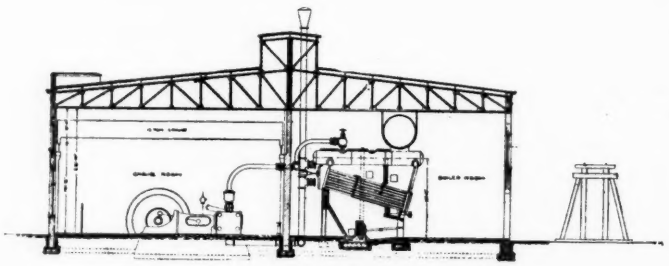


FIG. 1.—SECTIONAL VIEW OF PROPOSED PLANT.

In choosing a site one should be selected that will have railroad facilities and, if possible, a supply for condensing water, as a condensing plant will be desirable when the load has grown to a certain point. The site should be of suitable shape and sufficiently large to provide ample facilities for future extensions.

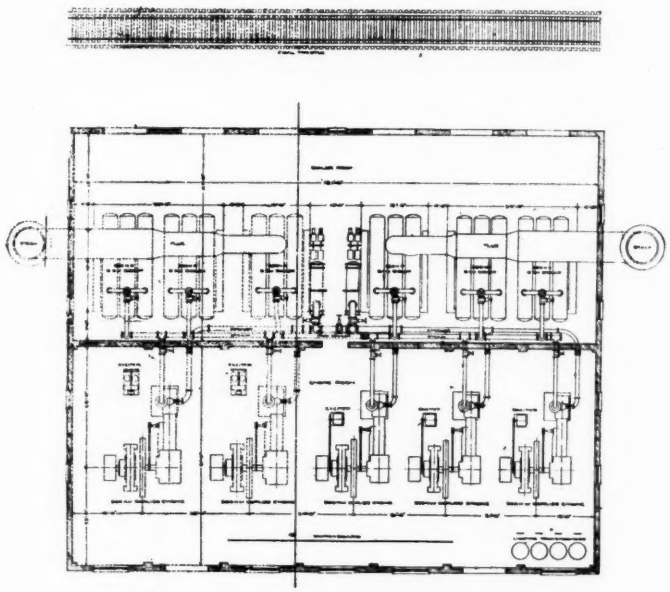


FIG. 2.—PLAN VIEW OF PROPOSED PLANT.

It is also desirable that there should be room on this property for stable or store room, as economy in the entire operation of the company will be gained by having all such buildings located at one point. The site chosen should, if it can be obtained without sacrificing other advantages, be close to the centre of the town. In this way distribution will become simpler and the plant itself and other

[1]Abstract of a paper read before the National Electric Light Association, Chicago, Ill., May 23.

buildings will be more convenient for the employés and more directly under the supervision of the manager.

The design of the engine and boiler room should, of course, provide for indefinite extension. This means a parallel engine and boiler room.

The station itself should be fireproof, with brick walls, concrete floors and steel roof. A crane in the engine room is desirable but not necessary. The gutters and flashings should be of copper, and window frames, doors, hardware and other details should be substantial, so as to keep down the cost of building repairs.

The stack should be of brick, as steel stacks will in every case be found to be the most expensive in the end, both because they require a constant maintenance charge for painting and because sooner or later they must be replaced.

For a small load, say under 1,000 horsepower, we believe that a simple non-condensing station will show the greatest total economy, including not only economy in operation but interest and depreciation on the apparatus installed.

Consideration should also be given to the fact that in such a station, with only a small number of men employed, it is impossible to obtain, for the wages paid, very expert men and that, therefore, the best results will be obtained by keeping all the apparatus as simple as possible.

The generating unit should be direct-connected with engines, preferably of the Corliss type, of moderate speed. The boilers may either be fire-tube or water-tube, but should be hand-fired, with no elaborate machinery for handling fuel or ashes. The station auxiliaries should be reduced to a minimum.

The exciters will be belt-driven from the engines, and the only steam auxiliaries will be a feed-water heater and the boiler-feed pumps.

The switchboard design should provide for exciter panels, located in the middle of the board, with sufficient space left for all future extensions. A Tirrill regulator will be found most desirable. Its first cost is low, and in a station where labor is to be reduced to a minimum it will be necessary to have such a voltage regulation if good service is to be given. With the exciter panels located in the middle of the switchboard, the generator panels will extend as may be needed on one end and the feeder panels on the other. All connections from the generators to the switchboard should be carried in cable under the floor, and the outgoing feeders should also be carried under the floor to a wire tower at the corner of the building.

Fuel should be delivered to the plant on a railroad siding extending the length of the boiler room and parallel to it. If possible a trestle should be installed, so as to provide headroom for dumping the coal from the cars, which can be stored under the trestle and wheeled to the boiler room as needed.

A general plan of the station embodying the above general ideas is shown in Fig. 1 and Fig. 2.

It will be noted upon examination of these drawings that the building suggested is extremely simple in design, and contains no basement, either under engine or boiler room. The steam piping is overhead with the exception of the free exhaust lines from the engines, and the arrangement is such as to give the shortest possible length of connections from boiler to engines.

While an ash hopper and basement under the boilers keeps the boiler room clean and enables more rapid and easier cleaning of fires, it increases the cost of getting out ashes and gives additional space to be kept clean. The additional cost is practically prohibitive.

The solid portion of the drawing indicates the building as it would be constructed for immediate needs: namely, a maximum load of 600 kilowatts, containing three 300-kilowatt units. The future extension to take care of the growth in load for ten years is indicated by dotted lines.

It is assumed that this station is to be built to meet a present maximum load of 600 kilowatts and that this load will be increased at the rate of ten per cent per annum compounded, and that the load-factor will be equivalent to 2,200 hours per year for each kilowatt of the maximum demand. This station can be built at a cost of from $125 to $150 per kilowatt.

Table I shows the growth in maximum load and output, and the station capacity installed to meet this load, for a period of ten years.

It will be noted that the original installation of three 300-kilowatt units would carry the load safely through three

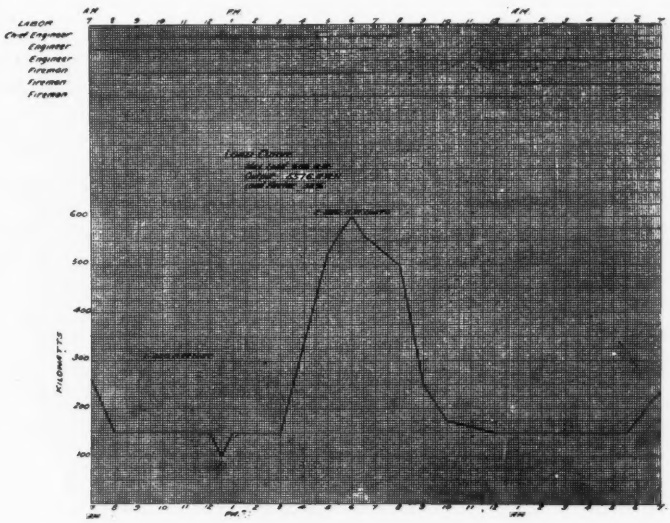


FIG. 3.—ASSUMED LOAD CURVE FOR AN AVERAGE MAXIMUM DAY.

TABLE I.

TABLE OF LOADS AND APPARATUS.

| Year. | Maximum Load. | Kw-Hour Output. | Units. | Total Capacity Kilowatts. | Available Capacity[1] Kilowatts. |
|---|---|---|---|---|---|
| 1908 | 600 | 1,320,000 | 3 300-kw | 900 | 750 |
| 1909 | 660 | 1,452,000 | ..... | 900 | 750 |
| 1910 | 726 | 1,597,200 | ..... | 900 | 750 |
| 1911 | 799 | 1,757,800 | 1 500-kw | 1,400 | 1,125 |
| 1912 | 879 | 1,933,800 | ..... | 1,400 | 1,125 |
| 1913 | 967 | 2,127,400 | ..... | 1,400 | 1,125 |
| 1914 | 1,064 | 2,340,800 | ..... | 1,400 | 1,125 |
| 1915 | 1,170 | 2,574,000 | ..... | 1,400 | 1,125 |
| 1916 | 1,287 | 2,831,400 | 1 500-kw | 1,900 | 1,750 |
| 1917 | 1,416 | 3,115,200 | ..... | 1,900 | 1,750 |
| 1918 | 1,558 | 3,426,700 | ..... | 1,900 | 1,750 |

NOTE—Yearly growth, 10 per cent. Output, 2,200 kilowatt-hours per maximum demand.
[1] Available capacity is largest unit down with 25 per cent overload on remaining apparatus.

years with one unit out of service, at which time a 500-kilowatt would be installed, which would carry it five years; a second 500 would then have to be purchased, which would give an available capacity more than sufficient to carry the load through the remaining three years.

The complete plans of the station, including the dotted portion, show all of these units installed, with necessary boiler capacity. Such a station would have a total capacity, with the largest engine out of service, of 1,750 kilowatts, allowing a twenty-five-per cent overload on the units available for service.

There is also given in Fig. 3 an assumed load-curve for an average maximum day. On this sheet is also shown the capacity of generators running to meet the load, from which it will be seen that the 300-kilowatt unit will be running at only approximately half load during the light portions of the day and night. This would, of course, increase the fuel consumption during these hours over what it might be with a small unit of exactly the necessary size to meet the present load. It is expected, however, that in a very short time the day load would be increased so that the 300-kilowatt unit would be operating under more economical conditions. Should the territory in which the station is operating be of such character that it is impossible to obtain any great amount of day load, it would be desirable, perhaps, to install a somewhat smaller unit than that shown on the plan.

The operation of such a plant would require a minimum of labor and repairs. From experiences with similar plants, a total of six men is amply sufficient, including one chief engineer, two running engineers, two firemen and one fireroom helper. The hours which these men should work are shown in diagram on the load-curve sheet. By lapping the chief engineer and the helper, we should have four men in the plant over the peak of the load.

The overlap covers the afternoon hours, giving the chief engineer the best opportunity to overhaul apparatus and providing him with the necessary help to carry on his minor station repairs.

With the plant as described there will be practically no continuous repair work, with the exception of that required to keep the boilers in first-class condition. There will be but two single-cylinder slow-speed engines and one boiler-feed pump running at a time during the peak, and only one engine and one feed-pump for twenty hours of the day.

As this is a non-condensing plant, the steam pressure will be low, not over 120 pounds, which will make it possible, with a small amount of labor and attention, to keep the piping, valves, packings and so forth, in perfect condition, so that there should be no excuse for their not being maintained always at initial efficiency, even with the limited station force employed. When the engineer of a station is relieved of the care and annoyance ordinarily caused by condensing apparatus, mechanical stokers, forced draft and other complications, his whole attention may be given to maintaining the efficiency of his boilers and engines and seeing that they are operated to the best advantage under the load conditions.

The following particular points are brought up as essential to the economical operation of the station:

In the engine room it will be important for the chief engineer to see that the capacity in apparatus running follows closely the load curve. All units should be run at their highest possible point of efficiency. It is always desirable to run them overloaded rather than underloaded, and the engineer should not be afraid of carrying his units up to their full overload point.

The chief engineer should certainly have an indicator and take frequent cards so that he may know at all times the condition of his valves and cylinders and remedy any defects that may show up.

But it is in the boiler room that the greatest possibility lies of wasting or saving fuel and improving the station economy. No positive rules for firing can be laid down in general, on account of the differences found between fuels, and also on account of the various methods of firing adopted by different men, which if properly carried out may result equally well.

The cutting in and out of boilers and banking of fires must be watched as closely as the running of the engine room to make the boiler capacity meet the loads most economically. With most boilers of good design it is found more economical to overload them twenty-five per cent above builder's rating and in order to carry a short peak to go to fifty per cent or more rather than cut in an additional boiler. The slight falling off in efficiency of a boiler at these high ratings does not consume as much fuel as that required to keep one boiler banked, which can only be used for a few hours a day.

With a non-condensing plant there is no difficulty in getting hot feed-water always above 200 degrees, so that this point will not trouble the engineer.

The combined boiler efficiency, including the grate and heating surface, can be kept up to the highest point only by constant attention to the condition of the boiler setting and the tubes. Draft gauges and thermometers, which cost but little and are very simple to use, will give the engineer exact information with regard to the condition of the boiler and help the firemen to get the best out of the boiler and the coal. A thermometer should be installed on the feed line into the boiler and draft gauges on uptakes and immediately over the fire. A high-reading thermometer for getting flue gases should be used by the engineer occasionally to tell him the temperature of his flue gases, which will be a guide on the efficiency of the boiler. Periodical readings of the draft at different points through the boiler should be made to determine the loss of draft and see if the air leaks are excessive.

One great source of loss of boiler efficiency is the bad condition of boiler setting, cracks around drums and other points in the setting which admit cold air, decreasing the draft and lowering the temperature. Most plants have an excess draft available from the stack, so that even with a very bad condition in this respect ample draft is still obtainable for burning the coal as fast as is required. This results in a continuous loss unknown to the engineer, unless investigation with draft gauge or by torches is made, as suggested.

Every one is perfectly familiar with the necessity of keeping the boiler clean, both inside and out, to maintain its efficiency. The frequency of such cleaning will depend entirely upon the quality of fuel and water used. An increase of ten per cent in boiler efficiency can easily be made, even where conditions are not very bad, by repairing, setting and cleaning boilers.

An automatic damper regulator is essential, especially in a small plant where natural draft is used.

It is hardly practicable in a small plant for the engineer to make elaborate tests, flue-gas analyses, engine-efficiency or evaporation tests, but the total running results of the plant can be kept very accurately by a proper method of records, and it is very essential for the chief himself to keep such records or station log. He is not responsible for two factors greatly affecting his cost: namely, the nature of the load on the plant and the

fuel furnished him. He can, however, by keeping accurate records, furnish the management with the information necessary for them to determine whether or not the fuel purchased is the best for the price and how the cost of production can be decreased by improving the load-factor. No scientific test is as good as a comparative run of several months under similar conditions.

In many plants of this size the output and the shape of the load curve are very similar from day to day and from month to month, so that, by obtaining the amount of coal burned and the output, a very accurate comparison can be made with different fuels, methods of firing and handling of the units.

It is essential, then, for the economical operation of a small plant that integrating wattmeters be installed on each generator and the daily output kept on the log sheet. The indicating instruments should also be read at sufficiently frequent intervals to enable a daily load curve to be plotted. Every pound of coal and ash should be weighed and the record turned in for each shift or period of load.

The engineer will have his pay-rolls and bills for material, so that with a very small amount of bookkeeping he can get the actual cost of labor, fuel, oil and waste, repairs to buildings, repairs to engines, repairs to boilers and repairs to electrical apparatus.

It is hardly possible in such a plant to subdivide the labor, as the ordinary repair work and maintenance of apparatus is done by the regular station help, part of whose time is also put into operating. Any extraordinary repairs requiring outside help or machine work will be entered up separately.

The engineer of the plant should not hesitate to try experiments in operating, provided, of course, the service is not endangered; such as different hours of cutting in and out boilers, overloading and underloading boilers, cutting engines in and out on the load at different hours. But these experiments will be of no value unless they follow out a definite programme to its final results and unless records are kept accurately and analyzed intelligently to compare the results obtained. Conclusions are often jumped at in station operating which at sight seem apparently correct but upon analysis prove to be entirely wrong. Good records and a careful analysis are the only proofs that can be accepted.

In taking hold of an old plant which is not operating at good efficiency it is difficult sometimes to locate the trouble and correct it. It is, of course, necessary to first secure accurate records as already described. This, however, will only show the total pounds of coal per kilowatt-hour and will not tell where the losses are.

The easiest point to be attacked first is the engine economy, which can be very readily brought up to its highest possible point with the engines in use. The records will then show if any gain in efficiency has been made.

After having brought the engines up to their best efficiency for the type, the boilers should then be carefully inspected and cleaned up. Boilers that have been neglected will require heavy expenditures to bring them up to a good standard of efficiency. This, however, must be done if the manager is determined to get good results from his plant in the end. No patching or partial cleaning of a boiler should be made unless it is absolutely necessary at the time to keep them in operative condition. Thorough repairs only will pay, but they will pay well in fuel saved, as the records will show if they are properly kept.

The operating costs of such a plant are given in Table II. The figures are conservative for a new plant, well built along the design suggested, and have been bettered in actual experience. Two columns of cost are given: First for a station having a load of 600 kilowatts and an output of 1,320,000 kilowatt-hours per year, and the other for the same station with twice the output and additional capacity necessary.

The figures for labor and fuel will vary considerably in different localities and under different conditions of the labor and fuel markets.

TABLE II.

OPERATING COST.

| Item. | Present Output. Amount. | Present Output. Per Kw-Hour. | Double Output. Amount. | Double Output. Per Kw-Hour. |
|---|---|---|---|---|
| Superintendent | $1,000 | 0.0757 cent | $1,000 | 0.0379 cent |
| Labor | 5,040 | 0.3819 " | 6,480 | 0.2454 " |
| Fuel | 9,723 | 0.7366 " | 19,446 | 0.7366 " |
| Water | 634 | 0.0480 " | 1,268 | 0.0480 " |
| Oil and waste | 600 | 0.0454 " | 800 | 0.0303 " |
| Miscellaneous supplies and expense | 500 | 0.0378 " | 600 | 0.0227 " |
| Repairs, buildings | 100 | 0.0076 " | 100 | 0.0038 " |
| Repairs, steam | 700 | 0.0530 " | 1,000 | 0.0379 " |
| Repairs, electrical | 75 | 0.0057 " | 100 | 0.0038 " |
| Total | $18,372 | 1.3917 cents | $30,794 | 1.1664 cents |

NOTES—Coal based upon Pennsylvania bituminous at $3.00 per ton, 5.5 pounds per kilowatt-hour.

Water based upon cost at 10 cents per thousand gallons, 40 pounds per kilowatt-hour.

Superintendent's salary at $3,000, one-third charged to production.

Labor: Chief engineer at $1,200 per year.
Two engineers at $900 per year.
Two firemen at $720 per year.
One helper at $600 per year.

## Electrical Action of Sodium.

Some additional information is given by C. E. S. Phillips in *Nature* (London), for June 11, regarding the power of sodium to dissipate electrical charges. This was referred to in the ELECTRICAL REVIEW for June 20. He now thinks that the greater or less effect due to different portions of the same rod was caused merely by inequalities in the temperature of the sections examined. By lowering the temperature so as to reduce the oxidation of the surface, a more complete diselectrification was produced. This result seemed at first sight to point to a cause other than chemical action. A slight current of air and even a soap film were sufficient to stop the discharging effect, also supporting the view that an electrified gas was emanating from the metal. A bright surface of potassium gave no appreciable discharging effect when cooled with a mixture of ice and salt. In all cases the surfaces could be seen in the dark to be glowing strongly. Further experiment has shown that no active gas can be driven from sodium by heat, and that the true explanation of the action lies in the positive electrification of the air surrounding the freshly cut surface. With warm sodium it is seen that the gold-leaf falls rapidly for a very short distance, while after cooling the action is more prolonged. It is clear, therefore, that the action in the first case, although violent, is so transient, owing to the whole surface being rapidly oxidized, as to appear of small amount. A far larger discharging action was obtained with reduced oxidation owing to the effect being more prolonged.

# REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

### An Electrical Pendulum Without Mechanical Connections.

The precise measure of time is a problem presenting a number of difficulties, since the oscillation of a pendulum is affected by temperature variations, barometric changes, variations in the friction of the escapement, and changes in the viscosity of the oil used for lubricating the movement. It has been estimated that fifty per cent of the driving power is lost in friction of the movement, and the latter is affected greatly by atmospheric conditions. When electrical or magnetic means are employed for driving the pendulum, instead of gearing, irregularities in the contact device may affect the swinging of the pendulum. To avoid all of these disturbing actions a pendulum has been designed by C. Fery in which an impulse is imparted to the pendulum without it being necessary for the latter to come into contact with any other body. For this purpose a horseshoe magnet is attached to the lower part of the pendulum, one end of which, as the pendulum swings, enters a small solenoid which gives it the required impulse to keep a swing of constant amplitude. The use of a horseshoe magnet is advantageous, as it renders the pendulum astatic and makes the magnet more permanent and more effective. The current flowing through the small coil is made and reversed by means of two contacts attached to a supplemental pendulum having the same period as the master pendulum and kept in oscillation by means of a copper ring at its lower extremity into which one end of the horseshoe magnet enters at one end of the swing. The eddy currents thus set up in this ring first move it along with the magnet in one direction, closing the circuit through the actuating coil, so as to give the master pendulum a pull. When the latter reaches the end of its swing and starts back, it drags the supplementary pendulum with it, due to the eddy currents set up, reversing the current through the driving solenoid and thus imparting a push to the master pendulum. In this way there is no mechanical contact and all the influence exerted upon the pendulum can be brought under perfect control. The entire apparatus may be enclosed within a sealed case protected from atmospheric changes and maintained at a constant temperature. This is made easier by the fact that the pendulum may be started from a distance by passing a current through the driving coil.—*Translated and abstracted from L'Industrie Électrique (Paris), June* 10.

### Electric Iron and Steel Furnaces.

In this concluding section of a study of electric iron and steel furnaces some of the latest induction furnaces constructed are described. The Kjellin furnace of the latest type has a magnetic core with three legs—two outside the circular annular crucible and one within. Furnaces of this type, with capacities of eight tons, are now being built. With the bulk of the charge the ohmic resistance decreases, while the self-induction increases, thus reducing the power-factor. To compensate for this the frequency of the current may be lowered. A 750-kilowatt furnace being constructed for the Volklingen works is to be fed with currents at 5,000 volts, five cycles, per second. The core length is eight and one-quarter feet in this case. Such low frequencies are not desirable, as they necessitate special generators. The Electro Metal Company, of Ludvika, Sweden, improves the power-factor by raising the bath resistance, which is accomplished by means of a bifilar trough, which follows the outlines of a figure U in a closed curve. A furnace for 5,000 volts, at fifteen cycles a second, is being installed in the Volklingen works, where the five-cycle furnace is in use. In the new furnace the trough is elliptic, having the general shape of the figure eight with the central bridge much broader than the outer limbs. Both cores of the transformer are thus surrounded by the trough, while the bridge portion affords a spacious hearth. The transformer primary is cooled by filtered air, and a secondary of a few turns, also air-cooled, is placed about each primary. The currents from the two secondaries are led to electrodes placed so that the circuit is completed through the bridge portion of the hearth, thus bringing the current density at that point up to what it is in the narrower sections. The greater part of the heating is, however, by means of induced currents. The whole furnace has a semi-cylindrical bottom to enable it to be rocked for pouring purposes. In lining the furnace hoops of iron are set in, which are utilized for heating and drying out the lining. In use this furnace is never completely emptied, about 1,600 pounds of steel being left in the hearth to keep it hot. A complete heat lasts from two to three hours. The power-factor of the furnace is said to be 0.87. The thermal efficiency is from fifty to eighty per cent. The furnace operates steadily, and the temperature is easily controlled by varying the applied voltage. Another type of induction furnace has been constructed by Schneider & Company, of Creusot, France, in which the desired high resistance of the bath is secured by contracting the hearth in two parts. This furnace consists of two chambers connected by L-shaped channels having relatively small cross-sections, each of which is spanned by a transformer core. The furnace is charged in the larger of the two chambers, about 1,000 pounds of molten iron being poured in first to act as conductor. It is mounted on three pedestals, two of which may be raised and lowered to cause the metal to flow through the channels. Usually, however, the difference in temperature is sufficient to maintain the circulation. In this furnace about three tons of steel can be refined in twenty-four hours, about 1,600 pounds being drawn off after each treatment. From 800 to 900 kilowatt-hours are said to be necessary to refine one ton of steel, and the efficiency is estimated at fifty-five per cent. If liquid charges were used entirely, the output of the furnace would be increased to fifteen tons. Although in the pure induction furnaces there is not supposed to be any electrolytic action, purification being due entirely to chemical action brought about by heat, the manner in which phosphorus and sulphur are removed suggests that the alternating current must have some additional action.—*Abstracted from Engineering (London), June* 12.

### The Cadmium Cell at a Low Temperature.

Although a great deal of research work has been carried out on the cadmium cell, it is surprising, says Henry Tinsley, that more attention has not been given to its

behavior with varying temperature, especially at low temperatures. A cold snap in last April enabled him to carry out some experiments on a batch of cadmium cells which he had made up according to the London National Physical Laboratory's specification. On completion these were found to be correct within three or four parts in 100,000 when compared with a standard cell which had been checked. During the cold spell the temperature of the room in which these cells had been placed fell as low as three degrees centigrade, when it was found that the cells of the batch showed a difference of 190 parts in 100,000 as compared with the standard, and were thus near two millivolts off. All of the cells showed good agreement among themselves. It was not thought that this variation was due to careless manipulation, otherwise greater variation among the thirty-six cells of the batch would have been expected, while this was found to be only ten parts in 100,000. A typical cell was taken from this batch and observations made upon it as the temperature of the room changed, readings being taken every half hour, and the test cell with a checked standard being placed in an oil bath. The lowest temperature observed was 3.2 degrees centigrade. As the temperature rose from this, the master cell showed a uniform decrease in potential from about 1.0199 volts at 3.2 degrees to 1.0192 at twenty-two degrees. The new cell taken from the batch, however, showed a potential of only 1.0181 at 3.2 degrees and the electromotive force rose rapidly with the temperature, being about 1.0195 at ten degrees, and crossed the check-cell curve at twelve degrees, the electromotive force then being 1.0196. The curve then turned over, reaching its maximum value at fifteen degrees, when the potential was 1.0197. At seventeen degrees the curve had become parallel to the check-cell curve and from there on apparently was a straight line, about 0.0002 volt above the line for the latter cell. From this curve it is seen that below fifteen degrees the test cell had a positive temperature coefficient and above this the coefficient had the normal sign. It seems evident from this that this change in the temperature coefficient can hardly be due to chemical effect, as there is no such alteration in the solubility of the cadmium-sulphate solution. Some other explanation must be sought. The new cells had been constructed with cadmium amalgam containing twelve and one-half per cent of cadmium. The amalgam in the check cell contained but ten per cent of cadmium, and it was noticed that the latter remained bright and liquid throughout the experiments, while the twelve and a half per cent amalgam apparently became solid and the surface took on a frosty or crystalline appearance. Above fifteen degrees the latter again appeared to be fluid and the surface was bright. Early experiments with the new cells showed that above fourteen degrees centigrade they are in excellent agreement with the master cell, not varying more than two or three parts in 100,000 from their mean. Mr. Tinsley suggests that this investigation seems to indicate, although it has not yet been proved, that the twelve and one-half per cent cadmium amalgam becomes solid at temperatures below about ten degrees centigrade, and thus departs from its two-phase system of cadmium and mercury. It is probable that a similar curve would be obtained for the ten per cent amalgam cell if the temperature were carried low enough. The twelve and one-half per cent amalgam cell is in favor in Germany, although F. E. Smith, of the National Physical Laboratory, has pointed out the necessity of paying attention to the percentage of the amount of cadmium used in preparing the amalgam.—*Abstracted from the Electrician (London), June 12.*

### Electricity or Gas?—The Problem of the Small Consumer.

Many years ago electricity was known popularly in England as "the poor man's light," but progress in gas lighting brought this expression into disuse. Now the development of high-efficiency incandescent lamps has turned the tables so that electricity should be able to live up to its former title. This is the view taken by J. D. McKenzie, who analyzes the problem presented in the supplying of electricity to the small consumer. When electric lighting was but little used the supply company could pick and choose its clients, and it generally completely ignored the small consumer. This policy can not be followed to-day. The electricity supply company must find some means of supplying light to the small home if it is to extend its field. In all large cities, and in many small ones, there are tens of thousands of homes requiring a maximum installation of from three to ten lamps, with a maximum demand of from one to five lamps at a time. Although the individual consumption may be very small, the aggregate would make a wide difference in the output of the central station. These small consumers are to a great extent grouped together closely, so that the supplying of them is a comparatively easy matter. The objections to the use of electricity by the small consumer are: First, the high cost of installation, and, second, the cost of using the supply. In other words, it is said that electrical apparatus is too expensive to install and the price for electrical energy is prohibitive. The author does not accept this view, for although the present price of metallic filaments is high, they are fragile, the price must come down, and improvements will surely be made mechanically: These objections, however, do not obtain for low-voltage supply, and hence need not be considered in the plan which he suggests. Regarding the cost of installation, it is cheaper to run a gas pipe than to lay underground cables meeting all the requirements of the Board of Trade; but many of these rules are unnecessary and there is no reason why a simpler method should not be adopted in which some relaxation of rules and regulations could be secured. Although it may be cheaper to lay gas pipe than underground cables, this should not deter the electric company from putting in its wires if it can see a profit in so doing; and if an overhead distributing system be provided for groups of houses, the electrical connection will probably be cheaper than the gas pipes. Moreover, in the majority of cases, the supply cables are actually passing the poor men's houses, many times merely to supply a light, short load. In such cases a short run of cable would be all that is necessary. Another item in the cost of installation is that of the meter. The average meter in use to-day is too expensive for this purpose. What is needed is one costing about $5 for a five-ampere load. The cost of electrical energy is then considered. This is found to be 5.2 cents per kilowatt-hour delivered to the consumer, not including any profit. This could probably be sold at six cents a kilowatt-hour and pay well. The cost of electric service is compared with that of gas, and the author says that from recent figures which he has obtained the cost for similar periods and identical conditions was 71 to 100 in favor of electric lighting where the price of energy was six cents a kilowatt-hour and that of gas sixty-six cents a thousand cubic feet. At this ratio electricity might be sold for ten cents a kilowatt-hour, which would be equivalent to gas at seventy-eight cents a thousand feet. The scheme of distribution proposed is to use a working potential of 200 volts alternating and to install a balancing autotransformer for each group of eight houses. From each branch of the transformer a supply is taken off to each house, giving twenty-five volts there. For a low-potential system of this kind elaborate precautions for the safety of the users are not necessary, and a much cheaper and simpler method of utilization may be adopted.—*Abstracted from the Electrical Review (London), June 12.*

# INDUSTRIAL SECTION

**ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS**

## The Westinghouse New Model Roney Mechanical Stoker.

One of the problems most prominently before engineers at the present time is that of obtaining large evaporative capacity with sustained efficiency and smokeless operation. This subject came up before the Smoke Convention held in Cleveland last week.

Owing to the extreme difficulty of getting firemen to stoke in the manner required to secure the desired results, it has been quite generally agreed upon by engineers that the mechanical stoker furnishes the simplest and the cheapest means of maintaining the conditions necessary for smokeless combustion, especially of long-flaming bituminous fuels. These conditions are especially difficult to realize, except by mechanical means, under the heavy demands encountered in the modern boiler plant—which often require steaming rates of fifty to 100 per cent above rating for long periods. The essential requirements for perfect smokeless combustion are:

(1) That the fuel be fed continuously to the furnace in small quantities in order that the volatile gases may be driven off at a uniform rate.

(2) That these volatile gases shall be mixed with sufficient air and maintained at a high temperature.

(3) A sufficient distance must be provided between the fuel bed and the heating surface of the boiler in order that the volatile gases will have time to be completely consumed before being chilled by contact with the comparatively cool surfaces of the boiler.

(4) A suitable grate with liberal air passages for consuming the fixed carbon remaining after the coking process.

(5) Some means of continuously agitating the fuel so as to bring all the particles of carbon into intimate contact with the air supply.

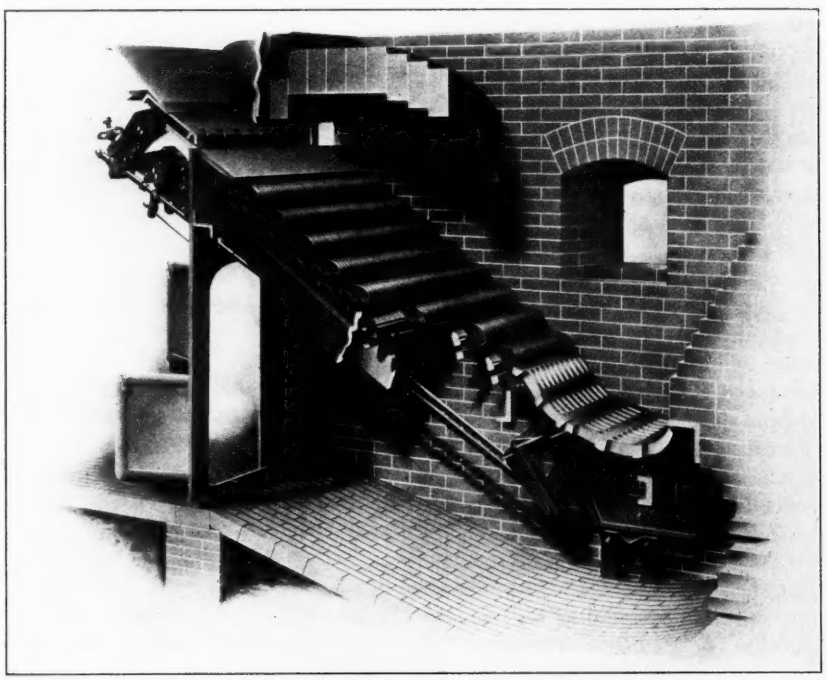
(6) From a mechanical standpoint the grate bar should have a large ratio of cooling to heating surface to permit higher rates of combustion, at the same time insuring a long life.

In addition to the above, to permit high rates of combustion with moderate draft pressures, the following are also necessary:

(7) An automatic means of agitating and advancing the fuel bed at the proper rate of combustion to suit the load carried.

(8) Adjustable area for admission of air through the grate, increasing with the rate of combustion, so as to avoid excessive pressure drop through the grates and the fuel bed.

These conditions have been carefully considered in the design of the improved stoker herein described, and the improvements embodied therein represent the gradual development from experience gained in the equipment of over a million and a quarter horse-power in boiler capacity. The following is a summary of the most important features of the New Model stoker later discussed in detail.



SECTIONAL VIEW OF NEW MODEL WESTINGHOUSE RONEY MECHANICAL STOKER.

FEATURES OF WESTINGHOUSE NEW MODEL MECHANICAL STOKER.

(1) Number of complete grate bars reduced one-half.

(2) Interchangeable parts (tops, webs, guards and dumping grates).

(3) Grate bars automatically centre themselves in side bearers by their own weight.

(4) No lost motion in grate movement due to wear, as grates return to inclined position by their own weight.

(5) Cooling surface of grate-bar tops 7.4 times the heating surface.

(6) Low cost of repairs, owing to small number of moving parts and long life of tops.

(7) Redistribution of grate-bar tops possible so as to equalize wear over all parts of the furnace.

(8) No threaded bolts inside of furnace.

(9) Non-sifting tops provided for first four rows of upper grates.

(10) Guards and dumping grates interchangeable without disturbing side or centre bearers.

(11) Improved leverage for operating guard and dumping grate, minimizing labor of handling.

(12) Thrust of connecting rod on rocker arm, direct—not sidewise—thus avoiding twisting forces.

(13) One hand adjustment for both grate movements.

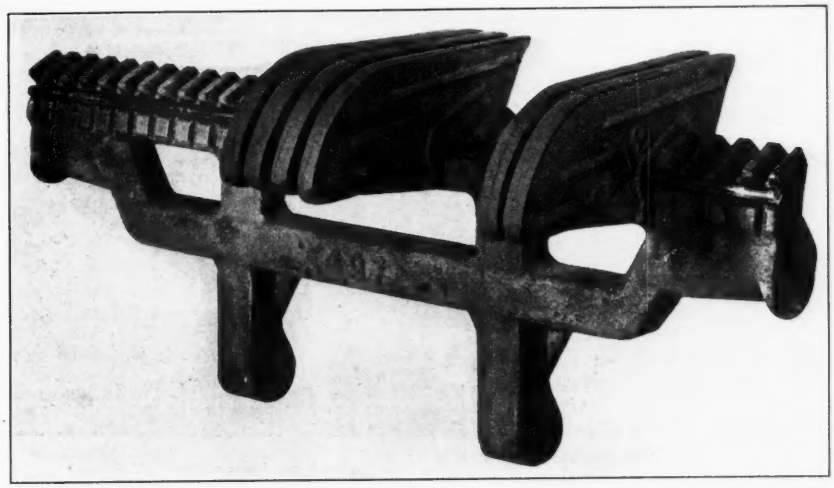
(14) Stop provided on each connecting rod to hold grates open for dislodging clinker.

(15) Improved air distribution over

arch, which cools the arch and heats the incoming air, thus preventing smoke.

(16) Baffles over arch direct air supply so as to obtain uniform air distribution over fire.

(17) Constant draft area through grate-bar tops practically two-thirds of total draft area.



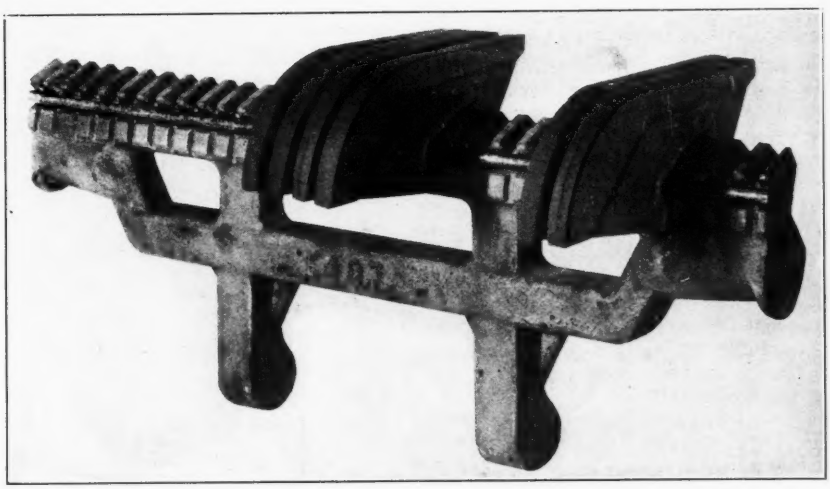
Upper Grate Bars, New Model Westinghouse Roney Mechanical Stoker.

(18) Moderate fluctuation in draft between limiting movements of grate bars.

GENERAL DESCRIPTION.

Reviewing briefly the general type, it will be seen that the coal is fed into a hopper extending across the boiler front, usually by gravity from an overhead bin. From this hopper the fuel is automatically supplied to the furnace by a reciprocating pusher operated from the rock shaft by an eccentric. The fuel descends through the throat of the arch on to the upper grate bars, where it is subjected to an intense heat radiated from the incandescent fire-brick arch spanning the upper portion of the furnace. This entirely cokes the fuel and drives off all the volatile gases, leaving the coke, or fixed carbon, which is then gradually worked down the inclined surface by the rocking motion of the grate bars, imparted to them from the eccentric on the rock shaft.

The oscillation of the grate bars not only works the fuel slowly down the furnace, but also keeps it constantly agitated, thus preventing to a large extent the formation of clinker, and bringing the fuel into intimate contact with the incoming air. After the solid combustibles have been totally consumed the remaining ash is discharged on to the dumping grate at the bottom of the furnace. The operations necessary to clean the fire are very simple. First the guard is raised to a position which prevents the fuel bed from sliding. Next, the dumping grate is dropped, permitting the ashes to fall into the ash pit.



Lower Grate Bars, New Model Westinghouse Roney Mechanical Stoker.

From the foregoing brief description it will be evident that all the essential conditions necessary for high rates of combustion and smokeless operation have been fully realized, *viz.*:

(1) Fuel is fed to the furnace at a uniform rate, depending upon the load.

(2) Fuel is coked in the presence of a preheated air supply.

(3) Combustible is brought into intimate contact with the required quantity of air for complete combustion.

SECTIONAL GRATE BARS.

One of the most important features of the New Model Roney stoker is the sectional grate bar, or fire top, illustrated herewith. For the upper four grates a non-sifting type top is used, provided with abutting horizontal ledges to prevent the fine fuel from sifting through the bars and at the same time permit a free entrance of the air. As only the thin edge of the fire top is exposed to the direct heat of the fire, while both sides and the bottom edge are cooled by the incoming air, it is evident that these tops are well protected from overheating, thus insuring long life. As previously mentioned, for each square foot exposed to the fire, 7.4 square feet of surface is cooled by the air, giving 7.4 times the cooling effect of the flat-top grate bar.

As will be seen from the illustration, the grate proper consists of a number of thin plates set on edge in V-grooves. These hook over a trussed web and are held in place by a key-rod slipped in from the end. They are, therefore, easily removed. The webs have conical bearing surfaces at the end, which makes them self-centering in the side bearers and prevents any uneven wear. By lifting the webs out of the bearers and removing the key-rods, the tops may be redistributed if desired, so as to equalize the wear in various parts of the furnace.

Eight samples selected from different parts of the furnace below the arch line after seven months' wear showed a maximum and annual depreciation of about sixty-six per cent, indicating a minimum life of one and a half years.

An average annual depreciation of about seventeen per cent was shown by these eight samples, indicating a probable life of about six years if the bars are redistributed from time to time. In the upper part of the furnace, however, the wear was practically *nil*. It should be noted that the boiler from which the samples were taken was subjected to unusually severe conditions, having been operated above rating practically continuously and

at times forced to 100 per cent above its rated capacity.

One of the principal advantages of the sectional grate-bar tops is that it reduces the amount of scrap when they have been sufficiently worn to be discarded. In this stoker, all internal parts are made interchangeable. No bolts are used and any part can be removed without disturbing the other.

GUARDS AND DUMPING GRATES.

The new type of guard prevents the fire from sliding into the ash pit when the dumping grate is operated. As the lower end of the guard is now raised, instead of cutting through the fire, as formerly, it not only makes it possible to dislodge from the fire all clinker formed at the bottom, but also provides an unobstructed descent for the ash and clinker separately. When dropped to its normal position it permits the lower edge of the fire to settle quietly without tendency to slide.

The new dumping grate is hinged about one-third forward, dumping both front and rear. Being nearly balanced, it is very easily operated. The upward motion of the dumping grate breaks up any clinker bridge tending to form between the grates and bridge wall. Both the dumping guard and grates rest in U-shaped trunions in the side bearers, the guard being simply hooked over the bearing rods. The latter can, therefore, be easily removed without dismantling any portion of the stoker.

ROCKER MOTION.

The rocking motion is transmitted to the grate bars by means of a connecting rod from the eccentric "agitator." As the grate-bar tops are unbalanced, they return to the inclined position by their own weight, and, therefore, only one feed adjustment is necessary, made by the sheath nut on the end of the connecting rod. As motion has to be transmitted to the connecting rod in one direction only by the agitator, a simple-looking device, or dog, is used for holding the grates open to permit rapid trimming of the fires.

AIR DISTRIBUTION.

As previously outlined, the most essential requirements for smokeless combustion are a gradual coking of the green fuel and an adequate supply of preheated air admitted above the coking bed. These conditions have received special attention in the design of the New Model Roney stoker. The air supply to effect the combustion of volatile hydrocarbons is admitted through two windgates located on either side of the stoker. It first passes to the rear of the fire-brick arch, extending across the front of the furnace, and is then directed by baffles to the crown of the arch, at which point it enters the front air spaces. From the latter it enters the furnace through the spaces between the stoker front and the first ring of arch brick. Passing the air over the furnace in this manner not only preheats the air, but assists materially in cooling the arch.

The fire-brick arch is of such extent and so designed that it completely cokes the green fuel and directs the gases downward over the hottest part of the fire, therefore permitting the volatile gases to be completely consumed before coming in contact with any of the boiler heating surfaces.

COMBUSTION.

With the grates open maximum width the effective admission area of the entire grate is 36.8 per cent of the project area of the furnace. At maximum opening—*i. e.*, in their lower position—the effective opening is 24.3; taking actual time of opening and closing, the average effective draft area of this type of stoker is 27.4 per cent of the total projected area, as compared with an average of 17.9 per cent with flat horizontal fire tops. This increased admission area makes it possible to maintain a higher rate of combustion. This has been very effectively brought out by a series of capacity tests conducted upon a 475-horse-power Babcock & Wilcox stoker-fired boiler at East Pittsburg. During these tests an output of over double rating, 224.7 per cent, was maintained for six hours, with but 0.42 inch furnace draft. This corresponds to a rate of combustion of forty-eight pounds per square foot per hour, with a very reasonable over-all efficiency of 63.5 per cent at this load. A test of twenty-five per cent above rating was maintained for six hours with 0.18 inch draft, with seventy-four per cent efficiency and twenty-three pounds of coal per square foot of grate per hour. The fact that the boiler and grate passed through this severe test without damage, while the brick setting was melted down, illustrates the effectiveness of the improved air distribution throughout the grates, and also the fact that a somewhat higher rate of combustion may be normally maintained with the same efficiency. In other words, a higher output per boiler unit.

APPLICATION.

The Westinghouse New Model Roney stoker has been adopted in about fifty plants for lighting, railway, railroad and industrial service, with such good results that many equipped with the older type are voluntarily changing over to the new. The extent of application of this new type requires but brief reference. Suffice it to say that its labor-saving ability has been appreciated to such an extent that in New York, for example, some of the large power stations are now being equipped with them.

## A Novel and Improved Indicator Reducing Motion.

A new and novel improved indicator reducing motion, on which patent has been lately applied for by F. H. and F. O. Ball, of the American Engine Company, Bound Brook, N. J., is seen for the first time as one of many novel details of the new American-Ball "Angle Compound" engine. It may be stated in the beginning, however, that there exists no physical reason why this indicator rig should not be applied to other engines, inasmuch as its design and construction involve no features which should forbid its use on Corliss type engines, or any other type of reciprocating engine.

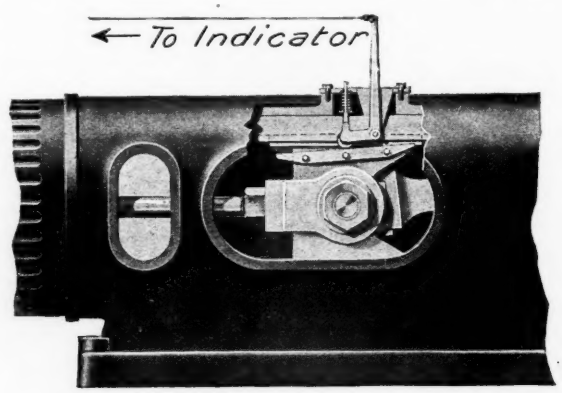



FIG. 1.—INDICATOR ATTACHED TO ENGINE.

The illustration, Fig. 1, A and B, shows the elevation and end view of the complete rig in connection with the cross-

FIG. 2.—TRANSLATING LEVER.

head. It will be seen that the device consists essentially in a slotted plate through which moves an L-shaped lever. At the elbow this lever is pivoted through a bolt, at the apex of a triangular slotted plate cast as one with the outer plate of the device, and at right angles to it. The

short arm of the L-shaped lever is forked. In the fork is set, by means of a pin, a small wheel or roller. Also connected with this arm is a pin which works through and at right angles to the outer plate. A helical spring, pressing against the outer plate and a disc resting on the shoulder of the pin, constantly tends to maintain the L arm at the extreme end of the slot. The device is fastened by bolts to the frame of the engine.

On the cross-head is secured, by means of bolts, a cast-iron cam plate or slide set at an angle in the vertical plane with the lower end directed away from the cylinder and at such an angle that the lower or front end is in the neighborhood of two inches below the rear end. The angle of this cam plate is determined by the length of the stroke of the engine, so that the same difference in height between the front and rear ends of the plate will be preserved in all cases. It will be seen that when the cross-head is in position nearest the cylinder the lower end of the cam plate or slide attached to the cross-head is in contact with the wheel or roller at the lower end of the L arm, and as the cross-head travels forward this wheel or roller with its arm is raised in exact proportion to the piston travel against the pressure of the spring; the reverse taking place as the cross-head returns. The strength of the coiled spring is sufficient to prevent any lost motion with this device, even in a high-speed engine. It will furthermore appear that the adjustment of the cam plate can always be so arranged that the travel of the upper end of the L arm is exactly that desired to turn the indicator cylinder the required distance without further reduction.

Referring to Fig. 2, it will be seen that on top of the exterior plate is a small flat trigger or lock which engages with a slot milled into the spindle or pin working in and out through the plate. Thus when the pin is pushed to its extreme top position, the trigger can be slipped into the slot and the rig instantly thrown out of engagement. It is but the work of an instant to release the trigger and to throw the indicator rig into service.

As far as the exterior appearance of this rig is concerned, the only visible portion is a highly polished oblong metal plate on the engine frame with a slot through which projects a six or seven-inch lever with a hole in the top. The indicator cord may be kept constantly attached to the lever and cards taken continually, if so desired, on the rig thrown in and out of service as many times as desired by the simple turn of a wrist.

## A New Ward Leonard Battery-Charging Rheostat.

Based upon a clear understanding of the work of a battery-charging rheostat and the requirements of an apparatus for this service, the Ward Leonard Electric Company, Bronxville, N. Y., has made a new departure in storage-battery rheostat design. A given minimum number of cells has a fixed minimum voltage, which in charging are opposed to the line-charging

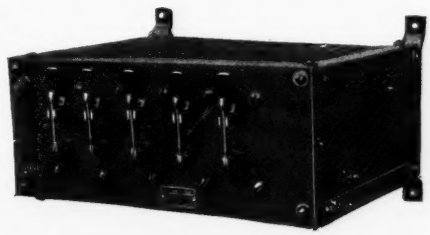


FIG. 1.—TYPE MC BATTERY-CHARGING RHEOSTAT.

volts; the difference between the battery volts and the line-charging volts is the maximum volts applied to the rheostat. In the Ward Leonard MC type rheostat, illustrated herewith, there are several switches in parallel, each switch controlling its respective resistance. Each resistance is designed to carry the maximum amperes that can be made to pass by the maximum volts that can be applied as stated above. To secure any charging amperes within the rating of the rheostat it is merely necessary to close the proper switches. There are five switches giving thirty-one steps of control. Each switch is marked with the approximate amperes that will pass when it is closed

FIG. 2.—TYPE MC RHEOSTAT WITH LINE SWITCH AND FUSES.

and all the other switches are open. By reading the switch markings the approximate charging amperes are gotten at a glance. It is impossible to cause an overload through the circuit, the cells being thoroughly protected from abuse.

The resistance elements are the standard Ward Leonard enameled resistance units. They are fireproof, strong and light, and are protected against chemical, electrical and mechanical depreciation. Any rheostat of the MC type, designed for a minimum number of cells, can be used to charge a greater number of cells but at a slightly decreased charging rate.

Twelve is the minimum number of cells used in electric carriages. Therefore the minimum battery volts are approximately twenty-four. Twenty-four volts opposed to a 120-volt line circuit leaves ninety-six volts to be used up in the rheostat. For pleasure carriages forty amperes are the maximum charging amperes. An MC rheostat as described, for twelve cells and forty amperes charging rate, has each switch and its resistance designed to be connected across ninety-six volts, and when all the switches are closed forty amperes will pass through

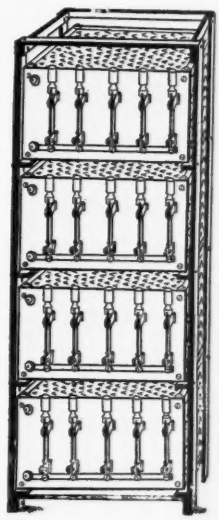


FIG. 3.—BANK OF TYPE MC SWITCHES FOR GARAGE SERVICE.

the circuit. Such a rheostat can be used to charge the following number of cells at the following charging rates:

With 12 cells in circuit a maximum charging rate of 49 amperes is obtained.

With 24 cells in circuit a maximum charging rate of 38 amperes is obtained.

With 30 cells in circuit a maximum charging rate of 28 amperes is obtained.

With 36 cells in circuit a maximum charging rate of 22 amperes is obtained.

With 40 cells in circuit a maximum charging rate of 18 amperes is obtained.

With 44 cells in circuit a maximum charging rate of 15 amperes is obtained.

Such a rheostat designed for any fixed number of cells is stated to be absolutely "fool-proof." The greater the number of cells the smaller the rheostat and the less the cost.

Fig. 1 shows the MC type rheostat as described; Fig. 2 shows this rheostat with a line switch and fuses added, making a complete installation, and Fig. 3 shows a bank of these rheostats for garage service.

## Educational Plans of Boston Edison Company.

The Edison Illuminating Company of Boston have completed arrangements with Professor Sydney Whitmore Ashe to carry on next winter a comprehensive scheme of educational work for its employés. The course which will be given beginning January 1 will be along lines somewhat similar to the educational courses carried on in the past two years by the New York Edison Company and the Brooklyn Edison Company. The number of lectures to be given will be limited to twenty, sessions being held both afternoon and evening, thus affording all employés an equal opportunity to attend. The course will be given directly under the supervision of the Edison Club, a special lecture committee being appointed for the purpose. Herbert W. Moses, president of the club, will be chairman of the committee. The lectures will be one and one-half hours in length, and will be both theoretical and practical, everything being demonstrated in an experimental manner.

## Changes in Electrical Engineering Course at Cornell.

At the fortieth commencement of Cornell University, occurring on Thursday, June 18, ninety-nine students completed the course in electrical engineering, a number somewhat smaller than that of last year, when 107 completed the course.

The curriculum in electrical engineering for next year has been modified somewhat. In accordance with the plan which has been followed for several years, more time and attention will be devoted to the theory of the characteristic performance of electrical circuits and machines. To provide this time in part the mechanical laboratory practice will cease at the middle of the senior year. The complete electrical course will then consist as follows:

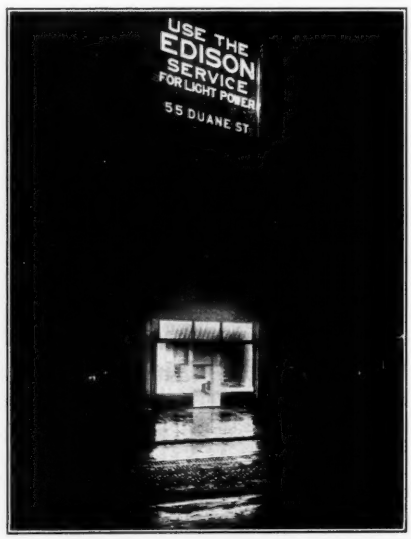
(1) Two recitations per week and one laboratory period per week throughout the junior year.

(2) Two lectures, two recitations, two three-hour computing periods, and two laboratory periods with one recitation per week throughout the senior year.

The instruction in electrical engineering in the junior year is intended to acquaint the students with engineering practice, and to indicate the main divisions of the field. The theoretical elements are reviewed to prepare the way for more thorough work in the senior year. During the senior year the purpose is to lay a theoretical foundation for future practice, by studying the performance of circuits and machines experimentally, and by predicting their performance from their dimensions and physical constants. During the second half of the senior year the students are provided with optional courses of a more practical nature, with a view to showing them how the theory is applied in particular lines of work, such as electric railways, transmission of intelligence, design of electrical machines, and power generation and transmission.

## A Fine Edison Tungsten Exhibit.

The New York Edison Company has established, at one of its branch offices in West Forty-second street, New York city, a very effective display of tungsten lamps. Across the front of the store are two windows about sixteen feet high by ten feet




THE EDISON DISPLAY WINDOW ON WEST FORTY-SECOND STREET, NEW YORK CITY.

wide and about six feet deep. A reflector, made up of small squares of prism glass, extends for a distance of about five and one-half feet down from the top of the window. The ceiling of each window is studded with twenty-eight 100-watt tungsten lamps, each lamp being equipped with a Holophane concentrating reflector. The sides and floor of the window are painted a dead white, and the angle at which the light strikes the window glass also increases the reflected light. Luminometer measurements in these windows gave readings ranging from ninety-three to 100 foot-candles. This, of course, is an extreme in window lighting to which few merchants would care to go. As a demonstration which attracts the attention of the passersby, however, it has been a complete success. Forty-second street, around this point, is very well illuminated, and the storekeepers are disposed to keep their windows well lighted. In spite of this generally good illumination, however, the windows of the Edison company form a remarkable contrast to the illumination all about them.

## President Whiteside Notes Marked Improvement in Business.

While in New York city last week, Walter H. Whiteside, president of the Allis-Chalmers Company, made the following statement to a correspondent of the *Wall Street Journal:*

"There is a marked improvement in general business. Within the last ninety days the bookings of machinery orders have increased from thirty per cent to fifty per cent of normal. The business for June to date indicates that at least sixty-five per cent of normal will be reached. New inquiries received are constantly increasing in number and volume. They are of a much more substantial character than at any time since the depression began. Their general tone denoted extensive plans in contemplation and for early development; the question of prompt shipment being already regarded an important consideration.

"The immediate requirements for a larger volume of new machinery for necessary extensions and improvements to existing plants are greater than for four years. This for the reason that with many operating companies purchases which under ordinary circumstances would have been made a year or eighteen months ago were put off, due to the monetary and other conditions, until to-day the factor of safety in these plants is becoming a serious matter and new equipment must be added.

"Unlike previous depressions, following which collections for comparatively long periods continued very unsatisfactory, there was a substantial improvement within a short time after the recent flurry, and at the present time collections are exceptionally good.

"While some difficulty may still be experienced in the way of financing entirely new undertakings, yet the financial condition of the relatively small buyer is on a sound basis and credits are about normal. In fact, the improvement in new orders placed is from the smaller class of purchasers, who are, commercially, an important factor. Of course, this class of business is widely diffused, but in the aggregate it is greatly stimulating improved trade conditions.

"The business outlook is distinctly encouraging."

# Current Electrical News

## DOMESTIC AND EXPORT.

NEW YORK APPELLATE DIVISION DECIDES THAT TELEPHONE SHARES ARE TAXABLE—The Appellate Division at Albany, N. Y., decided on June 19, in the case of Martin H. Glynn, comptroller, against Henry W. Conklin, as referee, and the Security Trust Company, of Rochester, that shares of stock sold on a public judicial sale by a referee who appeared by the court in an action to foreclose a mortgage are taxable under the stock transfer act of 1905. Conklin, as referee, sold at auction in Rochester 322,726 shares of Rochester Telephone Company for $250,000. The court orders judgment for the comptroller for $8,454.

HUDSON RIVER ELECTRIC POWER COMPANY'S PLANS RESTRICTED—The Public Service Commission of the Second (upstate) District of New York has abrogated the order of the commission of last December giving authority to the Hudson River Electric Power Company to issue $3,232,000 bonds under a consolidated and refunding mortgage for $30,000,000 executed by the company. This closes, for the present at least, the efforts of that company to develop on its own behalf the water power of the Sacandaga River. The State Water Supply Commission is now developing plans which will be submitted to the next legislature as to the water power of the Sacandaga River.

UNFAVORABLE REPORT ON LOUISIANA TELEPHONE BILL—The senate corporations committee, by a vote of five to four, on June 16 decided to report unfavorably on Senator Stafford's bill authorizing the people of all cities over 10,000 inhabitants to nullify the action of the city councils rejecting applications for telephone franchises, by a referendum election ordered for that purpose. The bill was opposed by Mayor Behrman, Senator Voegtle, C. H. Ellis and S. Locke Breaux, who reviewed the history of telephone agitation for the past year, and explained the present *modus vivendi* under which Cumberland Telephone Company is given a year's time to improve its service and lower rates, if it be found by the board of trade committee that such reduction be justified by its revenues.

NEW ORLEANS RAILWAY AND LIGHT COMPANY'S PLANS TO RETIRE FLOATING DEBT—The New Orleans Railway and Light Company has sold to George H. Burr & Company, $1,300,000 one-year six per cent collateral notes, the proceeds of which will be used to retire the floating debt of the company. The notes are secured by the deposit of $2,400,000 of the company's general mortgage thirty-year, four and one-half per cent bonds, which have been held in the treasury. The July, 1908, and January, 1909, coupons are to remain attached to these bonds, giving them an actual face value of $2,500,000. The bonds are now selling at between seventy-two and seventy-three. The company reserves the right to retire the notes at 101 on any interest date by giving fifteen days' notice. The Whitney Central National Bank, the Hibernia Bank and Trust Company, the Canal Louisiana Bank and Trust Company and the Interstate Trust and Bank Company, all of New Orleans, have agreed to loan the company an additional $700,000 to be secured by certain real estate which the company owns not covered by the general mortgage, of a value of about $300,000, and the equity in the bonds deposited to secure the $1,300,000 loan made by Burr & Company. It is understood that about $1,000,000 of the six per cent notes have already been sold. The balance is being offered at par and interest.

THIRD RECEIVER FOR NEW YORK CITY RAILWAYS—If plans now proposed are perfected, application for a third receiver will soon be made on behalf of the protective committee of the $12,500,000 collateral trust five per cent bonds of the Metropolitan Street Railway and the $16,604,000 refunding mortgage four per cent bonds. Whether or not application will be made and receiver appointed depends upon whether the two committees can come to an understanding in the matter or not. Since the receivers took charge the Third avenue has been cut out of the system and a separate receiver for it appointed. Separate receivers have also been appointed for the Union Railway Company and for its subsidiaries and for other subsidiaries of the Third avenue. The Fulton street line has been abandoned and a receiver for the company asked. The company has outstanding $500,000 of bonds. The receivers have petitioned the court for permission to default on the rental of the Central Park, North & East River Railroad Company, and the Twenty-eighth & Twenty-ninth Streets Railroad Company, and if permission is granted separate receivers for each company are likely. The abandonment of the line of the latter company, and part, or perhaps all, of that of the former company, may also follow. Up to the present time the defaults of the receivers amount to $7,751,308. This amount does not include the seven per cent dividend on Metropolitan's $52,000,000 stock or the rentals on the Central Park, North & East River Railroad and the Twenty-eighth & Twenty-ninth Streets Crosstown Railroad. In the face of these heavy defaults it has been necessary for the receivers to sell $3,500,000 receivers' certificates in order to get funds with which to put the lines in shape for operation.

FIRST DISTRICT PUBLIC SERVICE COMMISSION, NEW YORK, DENIES APPLICATION OF LONG ACRE LIGHT AND POWER COMPANY—Denying the application of the Long Acre Light and Power Company for permission to issue $10,000,000 of preferred stock and $50,000,000 of bonds, the Public Service Commission, on June 26, took the position that practically all the advantages of competition claimed by the applicant could be secured through the powers of the commission, while actual competition would cause inconvenience and expense to the public, and would ultimately be urged as a reason why rates should not be reduced to consumers. The Long Acre company was incorporated in 1903 for the purpose of manufacturing and distributing electricity for light, heat and power. The area to be supplied was at first defined as bounded by Fifty-ninth street, Fifth avenue, Thirty-third street and the Hudson River, but in 1907 it was extended to include all of the boroughs of Manhattan and The Bronx. The intent was to enter the field as a competitor of the New York Edison Company. The Long Acre company has $50,000 in capital stock and $500,000 in bonds outstanding. The proposed new issue of preferred stock was to be non-voting. Of the $50,000,000 of bonds it was proposed to issue at the present time only $12,000,000. They were to pay interest at the rate of six per cent and run for fifty years. The company also applied for permission to execute a mortgage on all its property, present and future, to secure the bonds. The company's application, when received by the commission, was referred to Commissioner Maltbie, who held numerous hearings, at which arguments for and against the application were made. Mr. Maltbie's report, which was unfavorable to the application of the company, was made on June 26 and adopted by the commission, and on his recommendation an order denying the application was issued.

## OBITUARY NOTES.

MR. M. C. MILLS, assistant superintendent of the Meadville & Cambridge Springs Street Railway Company, Meadville, Pa., died on Saturday, June 20, from injuries received in a collision on the morning before.

MR. WILLIAM HAMILTON YOUNG, manager of the Washington (D. C.) office of the Western Union Telegraph Company, and familiarly known throughout the United States as Colonel "Ham" Young, died on June 19 at the home of his son, Frank M. Young, in Chicago, Ill. Mr. Young was on duty connected with the Republican national convention, and was taken ill on the Thursday before his death at the Coliseum. He was one of the first telegraph operators of the country, and was the retiring president of the Old Time Telegraphers' Association. He entered the telegraph service in 1850, and during the Civil War served in the War Department.

## ELECTRIC LIGHTING.

WATERVLIET, MICH.—The electric light plant at Manton is to be operated by power from Cedar Creek.

DETROIT, MICH.—Tekonsha has voted down a proposition to bond the town for $12,000 for the purpose of installing a municipal electric light plant.

MILFORD, N. H.—Extensive improvements are being made at the electric light plant, including the addition of new machinery and a new chimney.

MARLBORO, MASS.—The Marlboro Electric Company will furnish current to the new municipal electric light plant which is to be erected at Shrewsbury at a cost of $15,000.

FALL RIVER, MASS.—The contract for installing an electric lighting plant in the Nos. 1 and 2 Granite mills has been awarded to Potter & Earle. About 3,000 lights will be required.

HAILEY, IDA.—The Idaho Consolidated Mines Company, Limited, has completed a hydroelectric plant at a cost of over $50,000. The power used is derived from Wood River, and will develop 1,200 horse-power.

ROSALIA, WASH.—Work has been begun on the lighting system here. Practically every business house in Rosalia will be supplied and numerous residences are being wired. The work will be pushed as rapidly as possible.

BINGHAMTON, N. Y.—The board of contract and supply has awarded a three-year contract to the Binghamton Light, Heat and Power Company. This will effect a saving of $13,000 as compared with the present cost of lighting.

CARROLLTON, KY.—The city council of Carrollton has let the contract for a new electric light plant. The contract includes a new 250-horse-power engine, a 250-kilowatt dynamo, and the erection of a new building, amounting to $19,200.

HARTFORD, CT.—The following directors of the Farmington River Power Company were elected at the annual meeting: E. B. Bennett, Henry Roberts, Atwood Collins, A. C. Dunham, John S. Hunter, H. C. Judd, W. W. Smith, James Terry.

BRISTOW, OKLA.—An election has been called for July 6 at which time the electors will vote on the proposition of a $35,000 bond issue for the purpose of installing a water system. It is planned to install a municipal light plant also.

TOPPENISH, WASH.—At a meeting of the city council A. H. Campbell and M. Kramer, of Seattle, were given a franchise to furnish electric lights and power for the city of Toppenish. The work is to begin on the plant within sixty days and to be completed within six months from date.

PATCHOGUE, L. I.—The village trustees have concluded a contract with the Patchogue Electric Light Company for lighting the village streets for five years. Under the contract the light company is to furnish 125 or more twenty-five-candle-power, metallized-filament lamps for $18 per year per lamp.

ATCHISON, KAN.—A contract for rebuilding the electric lighting system of the Atchison Railway, Light and Power Company has been let to the General Electric Company, of Schenectady, N. Y., at its bid of $23,640. The changes include new generators in the power-house, new arc lights in business houses and for street lighting, etc. The work will be in charge of Leonard Schaeffer.

SPEARFISH, S. D.—The success of the electric power and lighting plant, recently installed eight miles below this city by a syndicate of Spearfish men, has led the company to seek a location for another plant. One of the largest canal systems in the Black Hills will be built. The canal will furnish power to run an electric power plant at Beulah, Wyo., developing 1,800 horse-power. The power will be used in the mines of the Black Hills.

SALT LAKE CITY, UTAH—Engineers of the Utah Light and Railway Company are busily engaged preparing plans for the power plant to be built in Weber Cañon by the Harriman system. Actual construction work will begin within a few weeks, and the plant will be completed and ready for use this fall. The plant will generate 3,000 horse-power, which will be distributed in Salt Lake and Ogden. A dam for the conservation of water will be built on the Weber River, just above Devil's Gate.

DENVER, COL.—George Pullman Sanger, J. M. Blincoe and C. W. Lathrop have secured a franchise to furnish Arvada with electric light, and filed incorporation papers with the secretary of state for the Arvada Electric Company. They will spend $32,000 on a transformer plant in the town, to be furnished with power by the Denver Gas and Electric Company. The plant will provide electricity for light and fuel purposes and for commercial service. Later the company will operate in other parts of Jefferson County.

PUEBLO, COL.—The directors of the Colorado & Kansas Power and Transmission Company at a recent meeting elected the following officers: President, S. H. Atwater, of Cañon City; vice-president, Henry Warner, of Garden City, Kan.; treasurer, W. O. Bourne, of Dodge City, Kan.; secretary, E. W. Palmer, of Pueblo, and assistant secretary, L. M. Markham, of Garden City, Kan. Andrew McClelland, of Pueblo, tendered his resignation as a director. Surveyors are in the field and it is thought that work on the Cañon City-Pueblo branch of the project will be started within the next few weeks.

LANCASTER, N. H.—The electric light company formerly owned by Jones & Linscott has passed to a stock company in which the former owners are heavy stockholders. The new company will be known as the Jones & Linscott Electric Company, and is incorporated under the general laws of the state. The new company has among its stockholders a number of business men of the town. Officers have been chosen as follows: President, Harry H. Jones; treasurer, Fred S. Linscott; clerk, Merrill Shurtleff. Directors: Mr. Jones, Mr. Linscott, Mr. Shurtleff, C. W. Sleeper and W. H. McCarten.

DOVER, N. J.—The common council has entered into a ten-year contract with the Dover Electric Light Company for lighting the streets of the town at a rate slightly in excess of the rate of the old contract which expired July 1. The new contract allows $85 a year for each arc lamp, the same as heretofore, and $17 a year for each incandescent lamp, an increase of $1 per lamp. As a partial offset to the increased rate, the lighting company is required to light the police station, fire-engine house and other municipal buildings free of cost. Heretofore the company has been charging meter rates for this service.

BOULDER, COL.—The announcement is made by Curtis & Hine, of Colorado Springs, that the Eastern Colorado Power Company will at once resume work with a full force on its power project in this county. The project contemplates the expenditure of over $2,000,000 and will ultimately furnish something like 30,000 horse-power from the waters of Middle Boulder Creek, supplemented by great reservoirs for the storage of flood waters. For about a month the force has been increased gradually, and 150 to 200 men are employed. The force will be increased as fast as room can be made for the men until the full force of 600 to 700 men is at work.

## DATES AHEAD.

National Electrical Contractors' Association. Next meeting, Chicago, Ill., July 15-17.

Michigan Electric Association. Annual meeting, Grand Rapids, Mich., August 18-21.

International Association of Municipal Electricians. Annual convention, Detroit, Mich., August 19-21.

American Society of Municipal Improvements. Annual meeting, Atlantic City, N. J., October.

Illuminating Engineering Society. Annual convention, Philadelphia, Pa., October 6-7.

American Street and Interurban Railway Association. Annual convention, Atlantic City, N. J., October 12-16.

American Street and Interurban Railway Accountants' Association. Annual convention, Atlantic City, N. J., October 12-16.

American Street and Interurban Railway Claim Agents' Association. Annual convention, Atlantic City, N. J., October 12-16.

American Street and Interurban Railway Engineering Association. Annual convention, Atlantic City, N. J., October 12-16.

American Street and Interurban Railway Manufacturers' Association. Annual convention, Atlantic City, N. J., October 12-16.

American Electrochemical Society. Fall meeting, New York city, October 30-31.

## PERSONAL MENTION.

MR. C. E. CORRIGAN, vice-president of the National Metal Molding Company, Pittsburg, Pa., was a New York visitor last week.

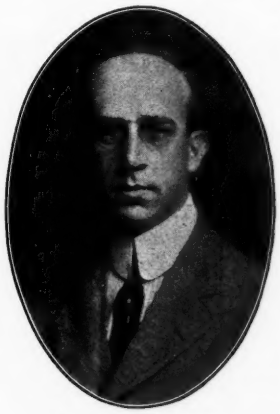
MR. T. F. SALTER, well known as an engineer in the field of hoisting and conveying apparatus, has been appointed to a new position as chief engineer of the Standard Roller Bearing Company, of Philadelphia, Pa.

MR. C. C. ADAMS, vice-president of the Postal Telegraph-Cable Company, has been receiving congratulations for the masterly and able manner in which he handled the telegraph facilities at the recent Chicago Republican convention.

MR. C. J. H. WOODBURY was the recipient of the degree of Doctor of Science, conferred by Dartmouth College, at its commencement, June 24, this being the second time he has received the same degree, the first being from Union College, New York, in 1906.

MR. AND MRS. WILLIAM J. DENVER, of Roxbury, Mass., announce the engagement of their daughter, Julia, to Mr. John W. De Crow, Yale, class of 1900. Mr. Denver is well known throughout telephone circles as the assistant general manager of the New England Telephone and Telegraph Company.

MR. W. N. RYERSON, whose election to the presidency of the Canadian Electrical Association was announced last week, was born in New York city in 1874. He was educated in the public schools and graduated in 1896 from the electrical engineering course of the School of Mines, Columbia University. After graduation he served for one year with the Sprague Electric Elevator Company in the testing and drafting departments. He then worked for six months with the Western Electric Company, in the switchboard designing department. For three years he worked with the Metropolitan Street Railway Company, New York city, in the construction and operating departments, and for three and one-half years was with the Manhattan Railway Company, New York city, and later with the Interborough Rapid Transit Company, first as chief operator of the generating station, and for the last two and one-half years as superintendent of substations for the Manhattan Elevated system and the New York city subway. Since April 1, 1905, Mr. Ryerson has been superintendent of the Ontario Power Company, of Niagara Falls, Ontario, in charge of construction, operation and local business management, including supervision of the sale of power. He is an associate member of the American Institute of Electrical Engineers, a member of the American Society of Mechanical Engineers, and a member of the Canadian Society of Civil Engineers.



MR. W. N. RYERSON.

## NEW INCORPORATIONS.

LANSING, MICH.—Home Telephone Company, Mulford. $15,000.

HARRISBURG, PA.—Mount Bethel & Mount Aetna Telephone and Telegraph Company, Myerstown. $10,000.

AUSTIN, TEX.—Postal Telegraph and Cable Company, of Texas. Capital decreased from $2,000.000 to $120,000.

MADISON, WIS.—Amacoy Telephone Company, Bruce. $1,000. Incorporators: E. C. Campbell, Burt Stevens and others.

COLUMBUS, OHIO—The Falls Heat, Light and Power Company, Cuyahoga Falls. $10,000. Incorporators: W. A. Scarl, S. D. Tifft, W. B. Middleton, C. A. Davis and C. K. Fowler.

LITTLE ROCK, ARK.—People's Light, Water and Power Company, of Newport. $25,000. Incorporators: F. R. Suits, president; George O. Beebe, secretary-treasurer, and Henry Baldus.

SPRINGFIELD, ILL.—McHenry Electric Service Company. To operate an electric light and power plant. $25,000. Incorporators: G. K. Paige, L. Howell, P. J. Boonstra, Chicago.

RALEIGH, N. C.—The Green River Telephone Company, of Rutherfordton. To construct and operate a telephone line from Rutherfordton to Green River, Polk County. $10,000 capital. Incorporators: John C. Mill, Poe W. Eskridge.

## ELECTRICAL SECURITIES.

In many quarters there is a well-defined impression that the stock market is due some time during the summer for another advance in prices, and this of substantial proportions. The reasons for this are not just now apparent, although reports are not disquieting, so far as business in general for this time of year is concerned. In fact the electrical field is feeling the impulse of a greater confidence in the near future, and, although business has fallen off very materially, orders in hand indicate a greater activity than was expected a month or two ago.

Dividends have been declared upon the following electrical securities: New England Investment and Security Company; regular semiannual dividend of 2 per cent on the preferred stock, payable July 1 to stock of record June 20. Washington Water Power Company, of Spokane, Wash.; regular quarterly dividend of 1¾ per cent, payable July 1 to stockholders of record June 20. Manila Electric Railroad and Lighting Company; regular quarterly dividend of 1 per cent, payable July 1 to stockholders of record June 20. Rochester (N. Y.) Street Railway Company; regular quarterly dividend of 1¼ per cent on the preferred stock, payable July 1 to stock of record June 23. Radio Telephone Company; regular quarterly dividend of 1 per cent and an extra dividend of 2 per cent, payable July 15 on stock for which full cash payment has been made prior to July 1, 1908. New York & New Jersey Telephone Company; regular quarterly dividend of 1¾ per cent, payable July 15 to stock of record July 6. Electric Storage Battery Company, Philadelphia Pa.; quarterly dividends of ¾ of 1 per cent on both common and preferred stocks. This compares with 1 per cent on each stock three months ago, and six months ago 1¼ per cent on each stock. The dividends were payable July 1. Mexican Telegraph Company; regular quarterly dividend of 2½ per cent, payable July 16. Bell Telephone Company of Pennsylvania; regular quarterly dividend of 1½ per cent, payable July 15 to stock of record July 3. Massachusetts Lighting Company; regular quarterly dividend of 1½ per cent, payable July 15 to stock of record July 1. Commonwealth Edison Company; quarterly dividend of 1¼ per cent, payable August 1. Philadelphia Company; regular quarterly dividend of 1½ per cent on the common stock, payable July 1. West India Electric Company; quarterly dividend of 1 per cent, placing the stock on a 4 per cent basis.

ELECTRICAL SECURITIES FOR THE WEEK ENDED JUNE 27.

| *New York:* | *Closing.* |
|---|---|
| Allis-Chalmers common | 10½ |
| Allis-Chalmers preferred | 34½ |
| Brooklyn Rapid Transit | 46¾ |
| Consolidated Gas | 123¾ |
| General Electric | 130 |
| Interborough-Metropolitan common | 10¼ |
| Interborough-Metropolitan preferred | 28 |
| Kings County Electric | 115 |
| Mackay Companies (Postal Telegraph and Cables) common | 63½ |
| Mackay Companies (Postal Telegraph and Cables) preferred | 63 |
| Manhattan Elevated | 132 |
| Metropolitan Street Railway | 23 |
| New York & New Jersey Telephone | 100 |
| Western Union (ex dividend) | 53 |
| Westinghouse Manufacturing Company | 55 |

| *Boston:* | *Closing.* |
|---|---|
| American Telephone and Telegraph | 117¾ |
| Edison Electric Illuminating | — |
| Massachusetts Electric | 46 |
| New England Telephone | 111 |
| Western Telephone and Telegraph preferred | 65 |

| *Philadelphia:* | *Closing.* |
|---|---|
| Electric Company of America | 10½ |
| Electric Storage Battery common | 29 |
| Electric Storage Battery preferred | 29 |
| Philadelphia Electric | 9⅜ |
| Philadelphia Rapid Transit | 15 |
| United Gas Improvement | 86 |

| *Chicago:* | *Closing.* |
|---|---|
| Chicago Telephone | 130½ |
| Commonwealth Edison | 97½ |
| Metropolitan Elevated preferred | 49¾ |
| National Carbon common | 69 |
| National Carbon preferred | 111 |

## ELECTRIC RAILWAYS.

MARION, IND.—Surveys have been begun for the new Marion-Logansport traction line, under the direction of Henry F. Coleman, of Logansport.

DOVER, N. J.—Salmon Brothers, of Ledgewood, have the contract to build the trolley line from Silver Spring Park to Bertrand Island, on the east side of Lake Hopatcong.

SHERMAN, TEX.—The longest interurban electric railway in the Southwest was finished on June 16. It is sixty-seven miles long and runs between Sherman and Dallas.

PORTLAND, ORE.—The power plant of the Portland Railway, Light and Power Company at Cazadero was partially destroyed on June 21. The plant is valued at $750,000.

PHILADELPHIA, PA.—The Northern Cambria Street Railway Company, operating out of Johnstown, Pa., and connecting important towns, has decided to issue $100,000 bonds to build to the town of Hastings.

JANESVILLE, ILL.—Judge Grimm, in the Circuit Court, having decided that the franchise granted the Rockford & Interurban Railway Company was not properly granted, a new franchise will be prepared and submitted to the town council.

NEW YORK, N. Y.—At a meeting of the board of estimate and apportionment a resolution was adopted granting the petition of the New York & Queens County Railway for a franchise to extend its road to Eleventh avenue and Thirty-sixth street, in the old village of Whitestone.

LA JUNTA, COL.—The articles of incorporation of the Kansas-Colorado Electric Railway and Power Company have been forwarded to the secretary of state at Denver for filing. This is the company which proposes building an electric line from Dodge City, Kan., to Cañon City.

BALLSTON, N. Y.—Frederick H. Beach was appointed receiver, on June 23, of the Eastern New York Railroad Company, an electric line twelve miles long. The industrial depression and financial panic, together with the failure of the Philadelphia banking house which carried the railroad's bonds, caused the receivership.

DENVER, COL.—O. F. Olson, who has been completing arrangements for the construction of the new electric line from Fort Collins, Col., to Hudson, has signed a contract with the Burlington Railroad for the delivery of the rails and ties at Hudson to build the line from Hudson to Kersey. He also signed a contract with a construction party.

GREELEY, COL.—D. A. Camfield proposes to build an electric railway from Greeley to Pleasant Valley. To do this it is said he will interest the Home Electric Light Company and secure power from its plant. If the road is built, it will be completed in six months and may be the forerunner of other lines to operate with Greeley capital.

MONTREAL, CANADA—The Montreal & Southern Counties Railway Company has opened offices at 605 and 606 Canadian Express Building, McGill street, Montreal. W. B. Powell is manager, and J. A. Burnett, superintendent and electrical engineer. Work is now proceeding on the Montreal-St. Lambert section of this road, and entry into the city of Montreal has been arranged for.

TACOMA, WASH.—The construction crew on the Tacoma-Seattle short line has been increased and the building of the line will progress rapidly all summer. Grading crews have been at work south of Young's cove on the north end of the line since the middle of May. Merle J. Wightman, one of the promoters of the road, is authority for the statement that the right of way has been secured and the location between Seattle and Des Moines decided on.

BELLEFONTAINE, OHIO—Citizens of Degraff and Bellefontaine are planning to build an electric line between the two towns. The management of Silver Lake Park, which lies between the two places, is also interested in the enterprise, and the Schoepf syndicate, controlling the Ohio Electric Railway system, which has a trunk line through Bellefontaine, has agreed to sell the power to this proposed new line, believing it would prove a valuable feeder.

FLINT, MICH.—In accordance with an order by Circuit Judge Wisner, the Detroit, Flint & Saginaw Electric Railroad, which has fourteen miles of road in operation, has been sold at public auction. Isaac Applebaum, of Detroit, who holds the bonds of the road to the amount of $250,000, was awarded the property on his bid of $50,000. The Detroit Trust Company, of Detroit, has been acting as receiver for the property. It is said that Mr. Applebaum will complete the construction of the line to Flint.

PITTSBURG, PA.—After two years' labor and the expenditure of more than one million dollars, the Ardmore Street Railway Company has completed its road between Wilkinsburg and East Pittsburg. The initial trip was made on June 19. The officers of the Ardmore Street Railway Company are: William Flinn, president, and George H. Flinn, treasurer. The directors are: William and George Flinn, John S. Weller, H. P. Haas and M. K. McMullin. The cars will be run on a ten-minute schedule until midnight.

STUART, IOWA—The first annual meeting of the stockholders of the Red Oak & Northwestern Interurban Railway Company was held recently at Red Oak. Twenty directors were elected. They are: B. B. Clark, A. R. Tracy, H. E. Dermer, Thomas Griffith, Gordon Hayes, O. J. Gibson, George C. Boileau, of Red Oak; L. D. Foote, S. E. Smith, of Grant; F. D. Martin, W. L. Battin, of Greenfield; F. O. Hinkson, J. R. Smull, A. C. Curtis, of Stuart; D. A. Field, G. W. Curtis, of Redfield; George W. Clarke, J. W. Russell, of Adel; N. C. Wragg, Nathan Nish, of Waukee. An executive committee was elected consisting of F. O. Hinkson, Stuart; W. L. Battin, Greenfield; George C. Boileau, O. J. Gibson and Gordon Hayes, of Red Oak. B. B. Clark was elected president, George W. Curtis, vice-president; M. N. Spencer, secretary, and Thomas Griffith, treasurer. The company is formed for the purpose of building an interurban railway from Red Oak through Grant, Greenfield, Stuart, Redfield, Adel, Waukee and to Des Moines. Much interest is manifested along the proposed route.

## NEW MANUFACTURING COMPANIES.

BROOKLYN, N. Y.—The Gore Arc Lamp Company has been incorporated with a capital of $50,000 to manufacture arc lamps. The incorporators are: G. I. Woolley, H. T. Berry and H. T. Asbury, Brooklyn.

JERSEY CITY, N. J.—The National Ignition Company has been incorporated to manufacture electrical devices and appliances, with a capital of $150,000. The incorporators are: F. C. Eberlin, A. Williams and G. W. Flaacke, of Jersey City.

## INDUSTRIAL ITEMS.

THE H. KRANTZ MANUFACTURING COMPANY, 160 Seventh street, Brooklyn, N. Y., is distributing a series of advertising folders devoted to its water-tight floor boxes and switchboards.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., is preparing to manufacture snap switches and lamp sockets in addition to the circuit-breakers and controlling devices of which it now makes a specialty.

THE F. BISSELL COMPANY, 226 Huron street, Toledo, Ohio, is celebrating the month of July with a calendar card to which is attached an imitation fire-cracker. The inference is that "it can't possibly hurt you" to give the company an order.

THE BROWN HOISTING MACHINERY COMPANY, Cleveland, Ohio, will be pleased to send to any one interested upon request its "O" catalogue, describing and illustrating "Brownhoist" machinery as adapted to the use of artificial gas, coke and electric light companies for the rapid and economical handling of coal, coke and other materials.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, has ready for distribution a circular describing its "Ferro" compound. This compound is a chemical iron cement for smoothing over and filling up blow holes, sand holes, etc., in iron and steel castings. Literature is also ready for distribution describing the company's "Anti-Sweat" pipe covering.

THE EDISON MANUFACTURING COMPANY, Orange, N. J., announces that, in the oil fields, gas engines are running twenty-four hours a day, seven days in the week, using Edison primary batteries, which do not have to be looked after, as far as their ignition is concerned, more than once or twice a year. At such times a few minutes are required to renew the cells.

THE ACHESON OILDAG COMPANY, Niagara Falls, N. Y., manufacturer of "Oildag" and "Aquadag," has elected the following

officers: President, Edward G. Acheson, Jr.; secretary, W. H. Arison; treasurer, A. M. Williamson. The president is a son of the well-known inventor and electric furnace expert, Edward Goodrich Acheson, who discovered the "Oildag" and "Aquadag" processes. The company's offices and works are at Niagara Falls.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, has ready for distribution a new bulletin entitled "Some Illustrations of the Triumph Motor Drives." This bulletin does not go into the details of construction, but shows particularly by means of illustrations the application of motors to the various types of machines, such as lathes, planers, printing presses, boring mills, hoists, etc. Copies of this bulletin will be furnished upon request.

W. N. MATTHEWS & BROTHER, 227 North Sixth street, St. Louis, Mo., are the selling agents for the Stombaugh guy anchors, which are in very wide use throughout the country. This anchor is operated on the corkscrew principle, going into the ground without digging a hole. Enormous strains can be put upon the anchor because it is set in the solid, undisturbed earth. Full information will be sent to those interested upon request.

THE SIMPLEX ELECTRIC HEATING COMPANY, Cambridge, Mass., has published catalogue No. 15, giving a very excellent presentation of its extensive line of heating and cooking apparatus. In addition to the descriptive matter and the large number of illustrations there is some valuable information given concerning the consumption of current and the cost of use. Copies of this catalogue will be furnished to those interested upon request.

THE GENERAL FIREPROOFING COMPANY, Youngstown, Ohio, announces the erection of an additional factory building 60 by 200 feet, which will be devoted to the manufacture of steel office furniture and office devices, including steel sections or "units," desks and tables. This furniture is finished to closely resemble oak or mahogany, and the difference can not be detected by sight alone. The steel furniture possesses advantages over wood in that it is fire-resisting, space-saving, durable and not affected by moisture.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is distributing a circular containing some valuable engineering data on the economy of the new "silico-vanadium" steel used in Pittsburg transformers. This comprehensive article is in the form of a six-page bulletin showing the difference between "high-efficiency" and "standard-efficiency" transformers, and is reduced to a dollars-and-cents basis. In computing core-loss costs the author has adopted one cent per kilowatt-hour as a basis, and a comparison is made between the actual cost of the two types of transformers.

THE SUNBEAM INCANDESCENT LAMP COMPANY, West and Bethune streets, New York city, has been meeting with great success in its exportation of American-made tungsten lamps. One of its correspondents in South Africa has recently sent the following communication to the company: "I have just heard from one of my customers, for whom you furnished the only lot of tungsten lamps for me, that those lamps which you sent are the best lamps in the market, and that in spite of the higher price he is ordering some more. This I am extremely glad to hear, and I hope that as a result of the trial he has given them a good market for the lamps out here may result. The lot which you furnished me came out with very slight breakage; in fact, there were only six lamps out of 150 which were broken in transit or in any way defective."

# Record of Electrical Patents.

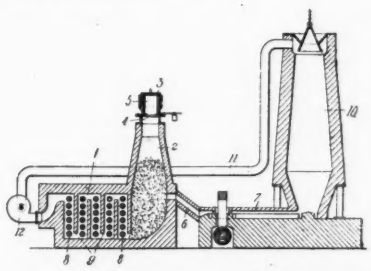
**Week of June 23.**

891,232. LIQUID RHEOSTAT. Herbert W. Cheney, Norwood, Ohio, assignor to Allis-Chalmers Company. The resistance is varied by raising one of the plates out of the electrolyte.

891,236. ELECTRIC-MOTOR CONTROLLER. John Dillon, Milwaukee, Wis., assignor to the Barth Elevator Company, Milwaukee, Wis. A relay switch is provided in the main circuit on each side of the motor, these being controlled by a derived circuit which includes the switches cutting out the starting resistance.

891,241. METHOD OF AND MEANS FOR STARTING DYNAMO-ELECTRIC MACHINES. Budd Frankenfield, Norwood, Ohio, assignor to Allis-Chalmers Company. The motor being driven above synchronism by an auxiliary motor.

891,248. SMELTING FURNACE. Eugen A. A. Grönwall, Ludvika, Sweden. The combination of a smelting furnace and an electrically heated refining furnace.



891,248.—SMELTING FURNACE.

891,254. ELECTRICAL WATER HEATER. Harry M. Hill, St. Louis, Mo., assignor to Hill Electrical Manufacturing Company, St. Louis, Mo. The water is passed between two conical electrodes.

891,263. ELECTRICAL APPARATUS. Charles J. Klein, New York, N. Y., assignor to Ralph A. Schoenberg, New York, N. Y. An outwardly opening plug receptacle.

891,264. DEVICE FOR THE PURIFICATION OF METALS. Charles T. Knipp, Urbana, Ill. A device for volatilizing a metal *in vacuo*.

891,265. PROCESS FOR PURIFICATION OF METALS. Charles T. Knipp, Urbana, Ill. The metal is volatilized in a vacuum by an electric arc and then condensed.

891,273. CLAMPING MEANS FOR CORE-PLATES OF DYNAMO-ELECTRIC MACHINES. Charles E. Lord and William H. Powell, Norwood, Ohio, assignors to the Bullock Electric Manufacturing Company. The core support is provided with an abutment and a circumferential groove in which a locking ring is seated.

891,303. SIGNALING SYSTEM FOR RAILWAYS. Louis H. Thullen, Edgewood Park, Pa., assignor to the Union Switch and Signal Company, Swissvale, Pa. A block-signaling system for alternating-current railways, one rail of which serves as the return for the power current.

891,306. ROTARY OIL-SWITCH. Hermon L. Van Valkenburg, Norwood, Ohio, assignor to the Bullock Electric Manufacturing Company. The contact fingers and drum are placed within a tank of oil.

891,316. DYNAMOELECTRIC MACHINE. Robert B. Williamson, Norwood, Ohio, assignor to Allis-Chalmers Company. The commutator segments are supported throughout almost their entire length and held in position by four locking rings.

891,320. INDUCTION COIL. Donald H. Yost, York, Pa., assignor of one-half to Frederick R. Yost, York, Pa. An electromagnet for bridging openings in an electric circuit.

891,323. FUSE. Bert A. Brown, Churchville, N. Y. A signal is set by the burning of the fuse.

891,339. RAILWAY SIGNAL. Franz Hirt, Berlin, Germany, assignor to General Electric Company. A railway signal responsive to polarized light only.

891,343. FLEXIBLE ELECTRICAL CONNECTION DEVICE AND THE LIKE. Charles A. Keller, Paris, France. A connection comprising a pair of laminated strips.

891,350. GENERATION AND TRANSMISSION OF MOTIVE POWER. George W. Mascord, London, England. A supplementary engine is automatically thrown in service when the load on the main engine exceeds a predetermined value.

891,352. TOWING SYSTEM. Wilbur L. Merrill, Schenectady, N. Y., assignor to General Electric Company. The barges are towed by a cable wound on a drum, the unwinding of which, due to increased pull on the cable increases the torque of the winding motor attached to the drum.

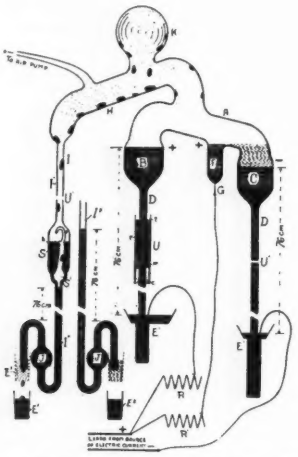
891,361. MEANS FOR ELECTROPLATING RODS, PIPES, ETC. Daniel H. Murphy, New Castle, Pa. Means are provided for rotating the pipe while plating.

891,395. TREATING SLIMES FROM ELECTROLYTIC REFINING OF LEAD. Anson G. Betts, Troy, N. Y. The slime is oxidized and then melted with a reducing agent to remove antimony.

891,400. ELECTRIC HEATER AND MEANS FOR CONTROLLING THE SAME. Peabody A. Brown, Denver, Col. The resistance elements are wound on a series of cores.

891,410. TROLLEY FOR ELECTRIC CARS AND THE LIKE. Edward J. Dacey, Prescottville, Pa. The wheel is mounted on a spring-supported swiveling cylinder.

891,414. THERMAL CUTOUT. Charles A. Ernst, Schenectady, N. Y., assignor to General Electric Company. An indicating fuse is carried on the outside of the case enclosing the main fuse.

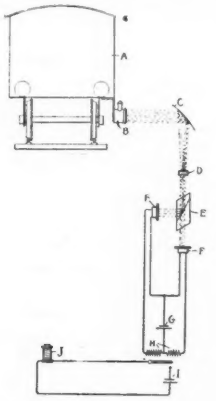


891,264.—Device for the Purification of Metals.

891,425. LIMIT-SWITCH DEVICE. Sam H. Kanmacher, Schenectady, N. Y., assignor to General Electric Company. A reversing controller with overload relays.

891,455. HOT-WATER HEATER. George L. Bennett, Trenton, N. J. A combined water heater, faucet and valve.

891,463. ELECTROTHERMAL PROTECTOR. Frank B. Cook, Chicago, Ill. A combined thermostat and lightning arrester.



891,339.—Railway Signal.

891,496. ELECTRICAL TRANSFORMER. August R. Luschka, River Forest, Ill., assignor to Western Electric Company, Chicago, Ill. An induction coil with the primary and secondary windings arranged in the form of two hollow truncated cones.

891,556. AUTOMATIC TRAIN-STOP. Joseph H. Lynch, Red Bank, N. J. A magnetically controlled pneumatically operated device for cutting off power and applying the brakes.

891,561. COMBINED ELECTRIC SERVICE CUTOUT AND METER BOARD. Henry E. McGowan and Edwin R. Ellsworth, New York, N. Y. Space is provided on the service board for the meter.

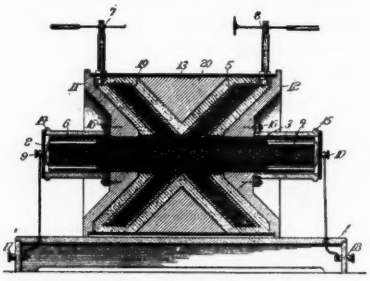
891,589. AUTOMATIC ELECTRIC REGULATOR. William L. Bliss, New York, N. Y. A regulator for controlling the voltage of a distributing system utilizing a storage battery.

891,617. ELECTRIC SWITCH-OPERATING MACHINE. Leslie A. Hedger, Mill Valley, Cal. The switch is operated by a coil and plunger magnet.

891,632. ELECTRIC BRAKE MECHANISM FOR CARS, ELEVATORS, CRANES AND OTHER PURPOSES. Michael E. Neenan, New York, N. Y., assignor to Otis Elevator Company, Jersey City, N. J. The spring-applied brake is retracted by an electromagnet, a supplemental magnet applying additional pressure on the brake-shoes when seated.

891,657. APPARATUS FOR THE ELECTRICAL PRODUCTION OF HEAT FOR COOKING AND OTHER PURPOSES. Arthur F. Berry, Ealing, England. The heating currents are induced in the heating element.

891,712. TROLLEY. Abel Molinar, Pittsburg, Pa. Spring-controlled wire guards are attached to the wheel.



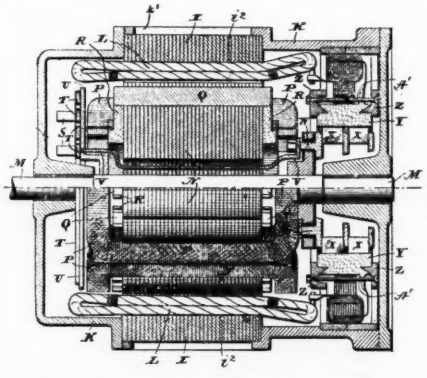
891,496.—Electrical Transformer.

891,720. MOTOR-CONTROLLING DEVICE. William C. O'Brien, Baltimore, Md., assignor to Monitor Manufacturing Company of Baltimore City, Baltimore, Md. A switch shunting the starting resistance is controlled by two solenoids, so that the resistance is cut out when the armature current has fallen to a certain value.

891,721. STARTER FOR ELECTRIC MOTORS. William C. O'Brien, Baltimore, Md., assignor to Monitor Manufacturing Company of Baltimore City, Baltimore, Md. A rocking switch controlled by two solenoids in the motor circuit which cuts out the starting resistance.

891,722. STARTER FOR ELECTRIC MOTORS. William C. O'Brien, Baltimore, Md., assignor to Monitor Manufacturing Company of Baltimore City, Baltimore, Md. A series of switches for cutting the starting resistance out of the motor circuit in steps, the action being controlled by two solenoids.

891,779. ELECTRICALLY GOVERNED AUTOMATICALLY OPERABLE TRAIN CONTROLLING SYSTEM. Harvey B. Miller, Staunton, Va., assignor of one-half to James A. Bell, Staunton, Va. An electromagnetic means for disconnecting the current collector.



891,784.—Single-Phase Commutator Motor.

891,780. AIR-BRAKE APPARATUS. Harvey B. Miller, Staunton, Va., assignor of one-half to James A. Bell, Staunton, Va. An electromagnetically controlled air-brake valve.

891,784. SINGLE-PHASE COMMUTATOR MOTOR. Stanley S. Seyfert, South Bethlehem, Pa., assignor of one-half to William S. Franklin, South Bethlehem, Pa. The commutator is attached to the outer stationary element of the motor.

891,786. TELEPHONE SYSTEM. Nathan H. Suren, Highlandville, Mass., assignor to the Gamewell Fire Alarm Telegraph Company, New York, N. Y. A combined signaling system and telephone.

891,797. METHOD OF AUTOMATIC REGULATION OF RECTIFIERS AND ROTARY CONVERTERS. Francis B. Crocker, New York, N. Y. The rectifier is regulated by introducing in the circuit inductance due to the combined effect of the alternating and direct currents.